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Automotive Steel Users Report Experience with H-BAND SPECS

• A Report of the Steel Users Subcommittee, Hardenability Division of the SAE Iron and Steel Technical Committee*

ABOUT three and half years ago the SAE and the American Iron and Steel Institute Technical Committee tentatively agreed upon a new method of ordering automotive alloy steels in accordance with hardenability as well as chemical analysis[1] specifications. It was hoped that this method of ordering steel would give better control of the response to heat treatment, and assure better properties in finished automotive parts. Last fall the Hardenability Division of the SAE Iron and Steel Technical Committee thought it might be well to make a survey of the automotive, tractor, and aircraft industries, and to determine the extent to which hardenability specifications were being used, and the results which were being obtained. Consequently a questionnaire was circulated among a number of users of alloy steels, and 27 replies were received.

Three years ago only one manufacturer was using the new H band, or hardenability specifications. By last fall, however, 14 of the 27 companies replying to the questionnaire were using the new hardenability specifications, and eight more were using some sort of hardenability specifications. Only five did not incorporate any kind of hardenability requirements in their specifications.

The increase in the use of hardenability specifications has been due to the beneficial results which have been obtained. It was thought therefore that it might be well to write a brief discussion of the hardenability specifications, and the results which have been reported by those using these specifications.

The hardest structure which can be produced with the most efficient quench is Martensite, but the hardness of 100% Martensite varies with the carbon content of the steel; however, maximum hardness is not materially affected by the alloy content. Thus a 0.50% carbon steel will attain a maximum hardness of Rockwell C 63.5 while a 0.35% carbon steel cannot be made harder than about Rockwell C 57.5.

The speed of quenching required to produce 100% Martensite depends upon the "hardenability" of the steel, which in turn depends upon the total effect of hardening elements—such as, carbon, manganese, silicon, nickel, chromium, molybdenum, vanadium, and boron—and upon the grain size and other characteristics of the steel. The higher the hardenability, the less drastic is the quench required to produce 100% Martensite.

Hardenability and Other Properties

It has long been recognized that there is a very close correlation between the hardness over the cross section, and other physical properties, such as strength and toughness. There is a very definite relationship between the tensile strength and the hardness of a test specimen. Other physical properties, such as, yield strength, ductility, and toughness, depend at least in part upon the degree to which the steel was hardened before tempering, and the final hardness produced by quenching and tempering.

Recently a great deal of attention is being given to the internal stresses which are set up by the heat treating practice. These may increase or decrease the useful strength of a steel part, depending upon whether the surface stresses are in compression or tension. The stresses which are set up, however, depend upon the response of the steel to the quench-

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[1] SAE-AISI Contributions to Metallurgy of Steel, No. 11—Tentative Hardenability Bands, July, 1944.

* Chairman of the Subcommittee is H. B. Knowlton, International Harvester Co.

ing operation, or in other words, the hardenability of the steel.

Control of Hardenability

The desirability of keeping hardenability within a narrow range has long been recognized. For some years before the war, numerous efforts were made to control hardenability by narrowing the permissible range for each of the elements present in steel. The present AISI-SAE specifications for some common alloy steels require the following close ranges of chemical composition, based on individual bar checks:

- Carbon .... 9 points
- Manganese .... 31 points
- Nickel .... 36 points
- Chromium .... 26 points
- Molybdenum .... 14 points

As a result, the steel makers had difficulty in producing all heats of steel within the narrow limits for the composition of all elements.

It was frequently necessary to request permission to ship steel which was out of specification so far as the percent of a single element was concerned. At the same time, the users occasionally found that a heat of steel which had all of the elements on the low side, but still within the legal specification limits, might lack sufficient hardenability. Likewise, a heat of steel having all hardening elements on the high side, but still within the specification, would increase the hazard of cracking or distortion.

With these points in mind, the AISI and SAE jointly agreed upon an optional method of ordering steel in accordance with hardenability specifications, which would eliminate about 3 or 4% of the heats, which were the lowest in hardenability, and a similar percent of the ones which were the highest in hardenability. It was felt that from the user's standpoint, it was a closer control of hardenability which was desired rather than a closer control of chemical analysis of individual elements. On this basis it was agreed that the mills should be allowed a slightly wider range of analysis for individual elements, providing the closer range of hardenability was produced.

Actually to produce a closer control of hardenability, it is necessary to maintain a closer control of the *total* chemical analysis, although a slightly wider range is permitted to facilitate balancing the composition.

As a result, a new series of specifications was set up which were similar to the previous SAE-AISI specifications, except that there was a published hardenability band for each steel and a slightly wider range of analysis for individual elements permitted. At first these were published for trial only. Since then, these specifications with certain modi-

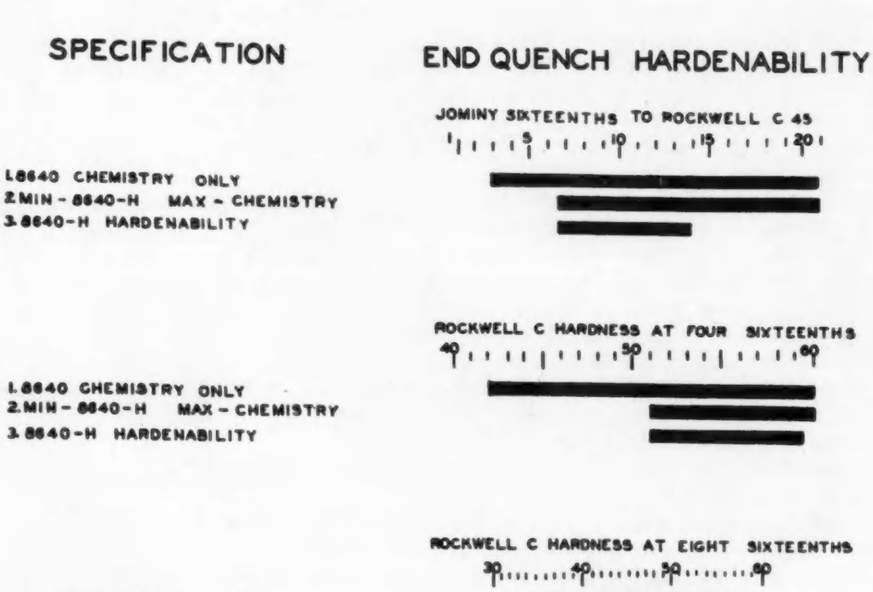


Fig. 1—How end-quench hardenability of SAE 8640 steel varies with method of specification

fications and improvements have been accepted as standard specifications.

It is believed that the comments received from those using H band steels are worthy of careful consideration, and that in the main they show the merit of the purchase of steel under hardenability specifications.

In this connection it must be remembered that the comparison being made is not between different *types* of steel, but between different *methods* of specifying the *same types* of steel. About 93% of all heats made to a chemical analysis specification should fall within the limits of hardenability of the H specification for the same type of steel. Consequently it must be expected that the performance in the heat treat, or in service of 93% of the heats purchased under chemical analysis specifications, will be identical with that of heats purchased under hardenability specifications.

It may be necessary therefore to use a fairly large number of heats of steel before any difference between purchase under analysis or hardenability specifications will become apparent.

A report showing no difference in the performance of steels ordered by the two methods is not of great significance, unless at least 50 to 100 heats of steel, or more, have been tried. On the other hand, a report of a few examples where either method of ordering proves superior to the other is of extreme importance. The objective of close limits of ordering steel is the elimination of the very small percent of heats which really cause trouble in the hardening room, or later in field service. The reports so far received have shown a number of instances where the purchase of steel under hardenability specifications has eliminated trouble.

However, no examples have been cited where trouble was experienced with steel purchased under hardenability specifications, which would have been eliminated by the use of the old standard ranges of chemical analysis.

The following is a brief resume of the answers of those users who have been specifying steel to the H bands, and are, therefore, in the best position to judge the effect of ordering by this method rather than by chemical composition alone:

1. Elimination of Insufficient Hardenability
   a. Carburizing Steels:
      (1) Low surface hardness—13 users commenting.
         - Reduced rejections with H steels 1
         - No difference 5
         - Insufficient data 7
      (2) Low core hardness—10 users commenting.
         - Reduced rejections with H steels 4
         - No difference 4
         - Insufficient data 2
   b. Heat-Treating Steels:
      (1) Low surface hardness—14 users commenting.
         - Reduced rejections with H steels 6
         - No difference 2
         - Insufficient data 6
      (2) Low cross sectional hardness—9 users commenting.
         - Reduced rejections with H steels 5
         - No difference 3
         - Insufficient data 1
   c. General Comments:
      There were no reports of difficulty due to H steels being lower in hardenability than those purchased to chemical composition only.
2. Effect of Hardenability Specifications on Warping and Cracking
   a. Carburizing Steels:
      (1) Quench cracking—14 users commenting.
         - Reduced rejections with H steels 1
         - No difference 9
         - Insufficient data 4
      (2) Distortion—14 users commenting.
         - Less distortion with H steels 6
         - No difference 4
         - Insufficient data 4
      (3) Uniformity of distortion—13 users commenting.
         - More uniform distortion with H steels 5
         - No difference 5
         - Insufficient data 3
   b. Heat Treating Steels:
      (1) Quench cracking—14 users commenting.
         - Reduced rejections with H steels 4
         - No difference 3
         - Insufficient data 7
      (2) Distortion—14 users commenting.
         - Less distortion with H steels 5
         - No difference 4
         - Insufficient data 5
      (3) Uniformity of distortion—13 users commenting.
         - More uniform distortion with H steels 5
         - No difference 5
         - Insufficient data 3
3. Machining, Forming, and Straightening Operations:
   Two users reported less difficulty with straightening, and three reported some improvement with regard to machining or forming of hot rolled or normalized bars purchased under "H" specifications.
4. Relation to Tempering:
   Six users reported fewer changes of tempering temperature with medium carbon H steels, and one with carburizing steels.
5. Tempered Hardenability Specimens:
   One steel sales firm has made a practice of recording Jominy hardenability as-quenched and as-tempered for three different temperatures on each heat of automotive alloy steel. They have reported that the Jominy hardness after tempering is very valuable in predicting the final hardness, which will be obtained after heat treatment. Very little work has been done on this proposition, but several users of steel have expressed an interest.

The fact that the new H specifications allow a little wider range of analysis so far as individual elements are concerned, has led to a misconception on the part of some users that these steels are not as closely controlled with regard to hardenability as the steels which are purchased under chemical analysis specifications.

This, however, is not the case. While the H-steel specifications do permit a wider range of analysis

Continued on page 64

TWO ways of doling more exacting gasoline quality needs to engines—antidetonant injection and dual-fuel systems—are proposed by these authors. Both methods stem octane number waste when driving wants are low, furnish high fuel quality only when operation demands it.

In his paper "Antidetonant Injection," (which will be printed in full in SAE Quarterly Transactions) Van Hartesveldt shows how to boost gasoline octane number with water-alcohol injection. Advantage of this antidetonant injection in high compression ratio engines, burning current premium gasolines, is presented by Potter, in his paper "Use of Antidetonant Injection in a High Compression Ratio Engine." Holaday discusses the second approach to more efficient gasoline usage—dual-fuel arrangements—in his "Progress Report on the Dual-Fuel System."

Following are digests of these papers.

GETTING

BASED ON PAPERS* BY

C. H. VAN HARTESVELDT
Vice President, Thompson Vita-Meter Corp.

Alcohol-Water Fluid Enriches Gasoline

Based on paper by C. H. VAN HARTESVELDT

An alcohol-water-tetraethyl lead antidetonant used through a fully automatic device named Vitameter will give octane numbers at costs competitive with refinery methods.

This new source of antiknock quality can be used in two ways. First, it may be added to low octane number, high burning quality gasoline to give both adequate octane number and important maintenance savings to commercial fleets. Second it will satisfy octane requirements of high compression ratio engines, when used with regular and premium gasoline grades.

Table 1—Road Octane Results With Antidetonant Injection

Vehicle	Octane Requirement	Solution Injected (Percent of Gasoline at Full Throttle)	Octane Improvement
Dodge Truck, Model WK '47	82	10.0	17
		20.5	27
		30.8	34
Chevrolet Truck '46	84	11.2	16
		18.6	26
		30.5	30
GMC Truck, Model 300 '46	80	11.3	12
		20.0	22

From a consideration of many factors, an 85-15 alcohol-water solution, containing 3 cc of tetraethyl lead per gal, was chosen as the optimum antidetonant.

Table 1 shows the octane improvement with this solution in different vehicles. Each was taken from regular service and had 5000 or more miles of combustion chamber deposit accumulation.

Because of many variables involved, rate of antidetonant consumption per octane number per gallon of gasoline burned varies. But enough experience has been gained to show that a considerable antiknock quality improvement is available, competitive costwise with, and in many ways cheaper than, refinery methods.

Sufficient data already is at hand on flange-mounted Vitameter installations to allow good estimates. A 188 tank-truck fleet has been operating with a 45% isopropanol-water solution as the antidetonant since June, 1947. Full-throttle injection rate averages 22.5% and overall usage has been 5.5% of gasoline consumed. This injection rate added 10 octane numbers on top of a 63-octane straight-run gasoline. The 10-octane number gain was achieved with 2.47 gal of alcohol per 100 gal of gasoline.

An 85-15 methanol solution, containing 3 cc of tetraethyl lead per gal, would yield the same results

* Papers were presented at SAE Summer Meeting, French Lick, on June 11, 1948.

MORE MPG's from OCTANE NUMBERS

R. I. POTTER
Chief, Fuels and Lubricants Service Division
The Standard Oil Co. (Ohio)

and **W. M. HOLADAY**
Director, Socony-Vacuum Laboratories,
Socony-Vacuum Oil Co., Inc.

for a 2.0% overall usage rate. This would require only 1.70 gal of the lower cost alcohol per 100 gal of gasoline.

In taxicab service, 19 octane numbers can be added to 58 octane number clear gasoline with maximum injection rate of 15%. Large airport limousines required up to 22.5% injection for a 25 octane number increment. Other consumption estimates are shown in Table 2.

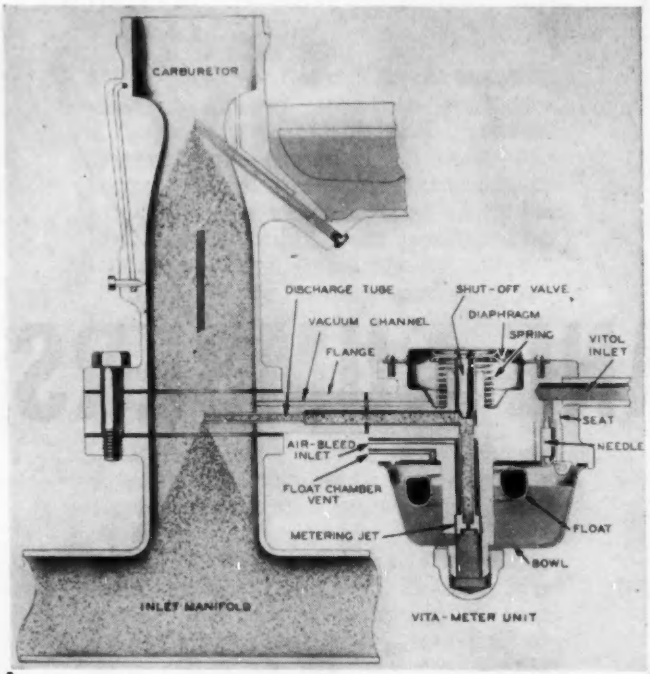
Alcohol-water solutions also produce a supercharging effect. Tests in one engine with the 85% solution indicates evaporation in the manifold, with a decrease in temperature and an increase in charge density. If the antidetonant is run with a fuel in octane number to engine requirement, the antiknock effect can be used to advance the spark for an increase in power.

From a maintenance standpoint, it is significant

Table 2—Antidetonant Consumption

TYPE OF FLEET	Number of Vehicles	ASTM Motor Octane Number of Base Gasoline	Road Octane Number Increment Added	Antidetonant	Gallons of Anti-detonant per 100 gal of Gasoline
Tank Trucks in Bulk and Home Delivery Service	188	63	8–12	45% isopropanol	5.5
" *	"	"	"	85% methanol, 3 cc tetraethyl lead	2.0
Tank Trucks in Bulk Delivery Service	23	59	19–23	"	5.2
" *	"	65	12–14	"	2.8
Tank Trucks and Trailers	10	59	19–23	"	11.8
" *	"	65	12–14	"	6.4
Taxicabs and Airport Limousines	65 } 23 }	58	18–25	"	4.0
" *		65	12–17	"	2.2

* Estimated



How Vitameter Works

A float bowl contains the antidetonant fluid, according to conventional carburetor practice. High manifold vacuum at idle closes the main valve and no antidetonant flows. This is also true at part throttle.

At full throttle, the diaphragm spring overcomes the force then exerted by the low manifold vacuum, the valve opens, and antidetonant flows. The point at which this occurs is set by the spring tension. Size of the interchangeable jet controls the amount of fluid drawn.

that alcohol-base antidetonants can be added to the fuel-air charge delivered by a conventional carburetor with an increase, rather than a decrease, in burning cleanliness. Add to this the fact that with antidetonant injection it is possible to use 60 to 65 octane number, high burning quality gasolines. This should reduce engine deposits in commercial fleet operation. In general, the higher the octane number from cracking and reforming processes, the more soot and sludge the fuel makes.

High Compression Engine Exploits Antidetonants

Based on paper by R. I. POTTER

Tests of a 9 to 1 compression ratio engine, using antidetonant injection together with premium gasolines, show these 85 to 90 octane fuels can be raised to 100 octane or better during performance periods calling for high octane requirements. This combination also makes available high octane gasoline for part throttle operation which can increase cruising fuel economy.

The engine used in this work was a 6-cyl stock model, converted to a 9 to 1 compression ratio by changing the piston design and using advanced design connecting rods and bearings. Stellite-faced exhaust valves also were used.

Fig. 1 shows full-throttle dynamometer octane requirement of the high compression engine with and without antidetonant injection. Note that the engine's octane need with a base fuel and antidetonant injection is only slightly higher than the requirement of a standard engine. The "needling" solution shows a 20-octane number improvement.

These antiknock quality increases required a maximum antidetonant flow equal to 31% of gasoline.

After the engine test stand work, the high compression ratio engine was installed in a current model car and equipped with an antidetonant injection device. Road octane requirements of both the standard and the high compression engines were of interest.

Under cruising conditions, the vehicle with the standard engine operated up to about 55 mph on zero octane reference fuel. Under most road load powers it operated easily with 50 octane number fuel.

The high compression engine, Fig. 2, required a 100 octane fuel for peak full throttle performance. It ran on zero octane number up to about 35 mph at road load. Part throttle octane requirements of this engine were purposely set high to take advantage of premium gasoline antiknock quality (about 85 to 90 road octane) and the resulting economy of lean

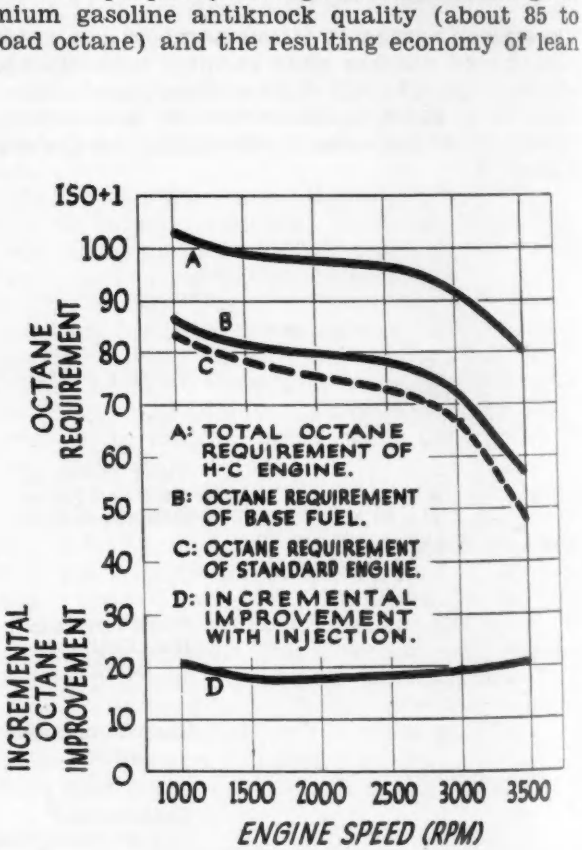


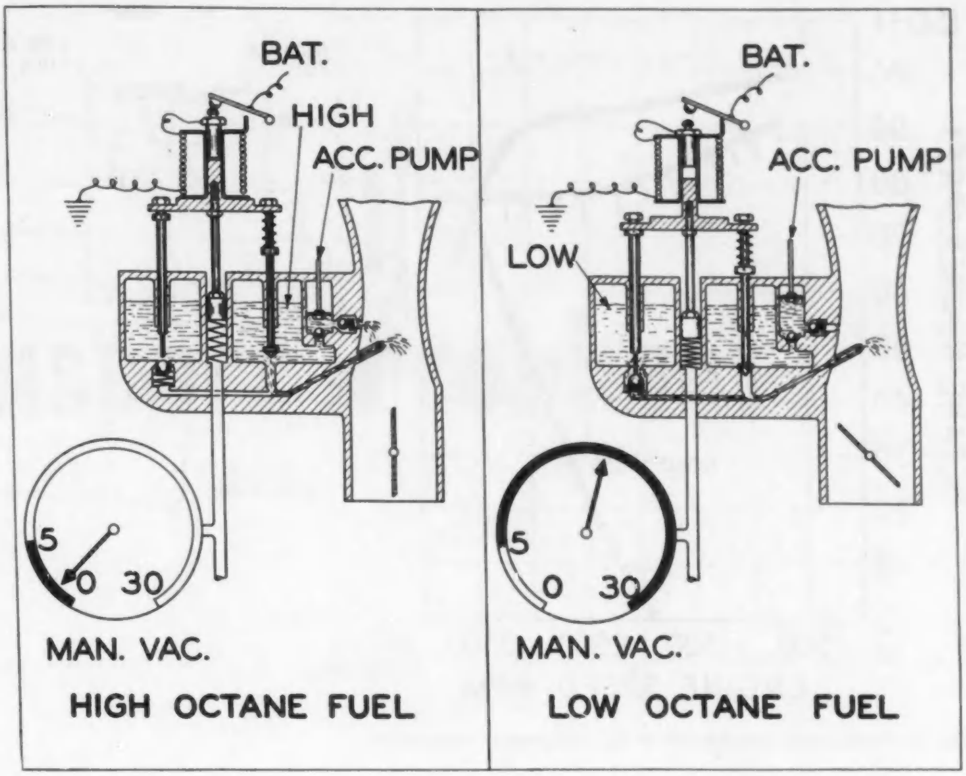
Fig. 1—Dynamometer octane requirements of the high compression ratio engine

Dual-Fuel Carburetor Operation

The bowl on the left contains low octane number fuel. This bowl supplies all the fuel for idle and part throttle operation, until the manifold vacuum drops to the predetermined changeover setting. At this point, the step-up piston rises sufficiently to close a contact energizing a magnetic coil. This causes the plate to be drawn upward, closing the jet in the bowl on the left and opening the jet in the bowl on the right.

The bowl on the right contains the high octane number fuel, which is supplied when the manifold vacuum is below the changeover setting. All of the fuel for the accelerating pump also is supplied from this bowl.

Changeover from one fuel to the other is instantaneous, to eliminate any interruption in performance and to minimize blending of the two fuels in the carburetor passages. When the engine is stopped, the jet in the bowl on the right remains open until the engine is started. Thus, starts are made on the high octane number fuel.



part throttle carburetor mixtures. Part throttle octane requirement can be made higher or lower by varying the vacuum-operated spark advance mechanism. That this vehicle shows less fuel consumption under road load than with the standard engine is believed due, in part, to this principle. This makes it readily adaptable to antidetonant injection.

A comparison of fuel consumption in the high and low compression vehicles under comparable driving conditions is given in Table 3. To get accurate information, trips were made with two cars running over the same terrain, making the same stops, with alternating drivers.

Table 3—**Comparison of Fuel Consumption for High Compression Ratio and Standard Engines**

	Standard	High Compression
Cross-country trips, including some city driving and hilly terrain:		
Miles per gallon of gasoline	19.5	22.2
Percentage increase in gallonage		13.7%
Percent antidetonant solution to gasoline used		2.9%
Miles per gallon antidetonant		771
City trips:		
Mileage per gallon of gasoline	15.9	19.1
Percentage increase in gallonage		20.1%
Percent antidetonant solution to gasoline used		8.8%
Miles per gallon, antidetonant		220

Feeding Two Fuels Brings Octane Thrift

Based on paper by W. M. HOLADAY

Fuels for more economical, high compression ratio engines can be made available provided the high octane number fuel can be used for only that portion of the time when the engine requirement is high. To achieve this, a dual-fuel system was devised that supplies high octane number fuel when the manifold vacuum is low, low octane number fuel when the manifold vacuum is high.

A schematic of the system with the Carter dual-fuel experimental carburetor is shown in Fig. 3. Provision is made for a two-compartment fuel tank, lines from each tank to a double fuel pump, and lines from the pump to a dual-fuel carburetor.

This installation was tested in the number of cars under various driving conditions—country, mountain, city, and city and country. Most of the tests were conducted at a vacuum fuel changeover setting of 5.5 to 6 in. hg.

Consumption of high fuel is plotted in Fig. 4 against manifold vacuum changeover setting for city and country driving, city driving, and mountain driving. It shows that consumption of high octane number fuel increases with increase in manifold vacuum for changeover. Rate of increase over the range of 4 to 8 in. hg is about 3 to 3½% per in. hg manifold vacuum increase for city and for city and country driving. For mountain driving, consumption of high octane gasoline increases about

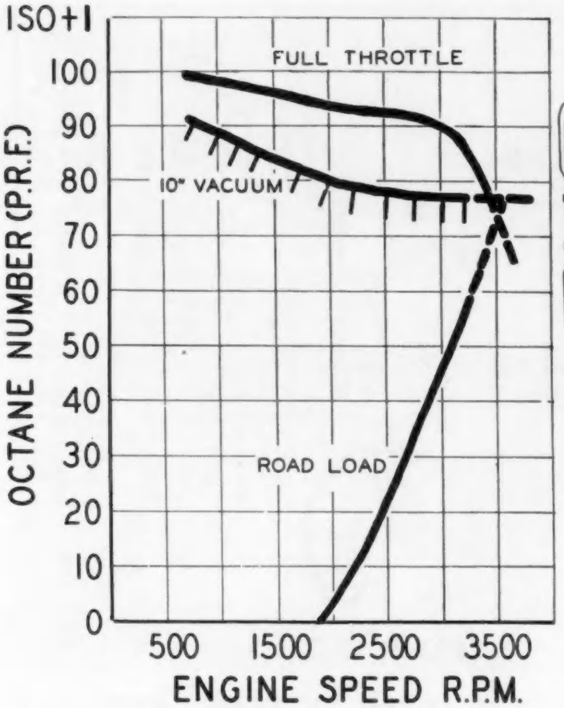


Fig. 2—Road octane requirements of high compression ratio engine

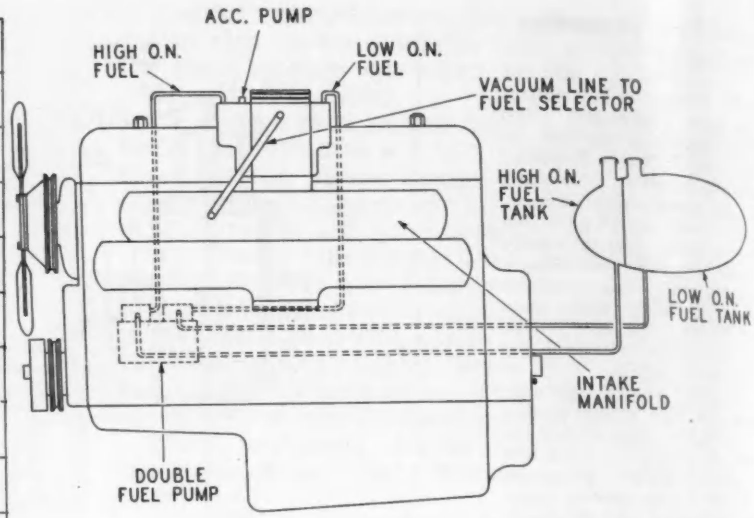


Fig. 3—Schematic of automatic dual-fuel carburetion system

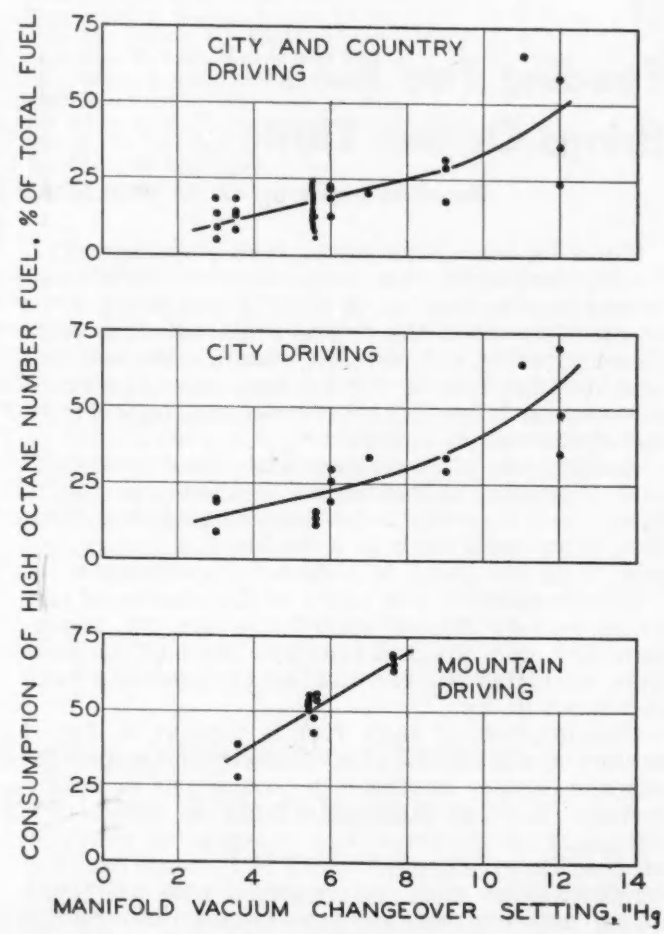


Fig. 4—Effect of manifold vacuum changeover setting on consumption of high octane number fuel

8% per in. hg increment. Fig. 4 also shows that high fuel consumption for city driving is only slightly higher than for city and country driving. Level for mountain driving is appreciably higher.

Thirty-two city and country runs covering 56,000 miles (at a manifold vacuum changeover of 5.5 to 6 in. hg) substantiate this. Average consumption of high octane number fuel was about 16%. In seven city runs covering 700 miles in heavy traffic driving, the average was about 22%. The average for seven mountain runs totaling 600 miles was 52%.

Thus consumption of high fuel under normal driving conditions (with a 5.5 to 6 in. hg setting) seems to be less than 20% of total fuel burned.

Data on four cars of one make show an average consumption of 18%, a high figure of 23%, and a low of 15%. Four cars of a second make gave an average of 18%, a high of 24%, and a low of 13%. Five cars of a third make gave about the same spread between high and low as the first two makes, but produced a much lower average—14%. These results indicate an appreciable spread among individual drivers because of variation in driving habits. Variation in consumption among different makes of cars (all were 1946 and 1947 models) is small in comparison.

Utility of a dual-fuel system has not as yet been established beyond question. But the work thus far does show: (1) that consumption of high octane number fuel for a significantly high manifold vacuum changover is in the range anticipated—15 to 25%, and (2) that a suitable, smoothly-functioning dual-fuel carburetor can be constructed and incorporated as an integral part of modern engines.

(A symposium containing these three papers in full together with a transcription of the complete discussion of them is available as SP-102 from SAE Special Publications Department. Price: $1.00 to members, $2.00 to nonmembers.)

AIR Transport Problems

EXCERPTS FROM PAPER* BY

E. S. LAND

President, Air Transport Association of America

I shall attempt to outline in question and answer form some of the things the air transport industry is thinking about. If the old dictum holds true that a man isn't really crazy just because he talks to himself, but that he's really at the danger point when he gets to answering his own questions, you may place full responsibility upon me, and not the ATA or the air transport industry. For I am reserving the right to express my own opinions without committing anyone else.

The first question is really basic. What does the air transport industry offer to the public?

The usual answer is "speed." My answer is "time." It is my belief that the saving of time is the greatest peacetime asset we have to offer. Travel across the continent is less than 12 hr by air. Mail is delivered between the most distant points in the nation in 12 to 18 hr. Shippers take advantage of the lessened time of nationwide distribution brought about by the linking of 2500 communities with interlocking air and surface transport. From an emergency point of view, the air transport industry is an auxiliary to the armed services in much the same manner as is the Merchant Marine—each of them offering its own kind of mobility that adds to a complete defense.

2. What are the difficulties in financing the airlines?

After the war, in the fall of 1945 and in 1946, the airlines undertook a tremendous expansion program. It was inaugurated because:

a. Demand for airline passenger transportation in 1946 was at a rate which brought three times as many passengers to the airlines as in 1941;

b. Domestic routes, shortened during the war, were restored and extended. International routes were reconverted from military control to private operation. New planes were needed for both;

c. Larger, more comfortable transport planes were on the drawing boards; planes designed to fly faster, in higher altitudes and to provide more nonstop services between the larger cities.

These planes were at the planning stage in 1944. One type was then estimated to cost five and one-half times the cost of a new prewar DC-3. When the first of these planes was delivered in 1946, instead of a cost estimated in 1944 at $550,000, there was a price tag reading $800,000. In other words, the new plane would carry less than three times the number of passengers as the DC-3, but the price of the new plane was eight times the 1940 purchase price of a DC-3. And one of our larger companies has estimated that the cost of training, of disruption to operations and maintenance, and of other expenditures required for introduction of a new type of plane amounted to $8,000,000 in 1946, in addition to the costs for equipment and spare parts. This is in an industry where engineers are fond of saying that a plane type is obsolete as soon as it goes into service. The hard fact remains that airplanes are depreciated generally on a four- to seven-year basis. Contrast that with a Pullman car, which has a life expectancy of 27 years.

Pilots' salaries in some cases went up as high as $12,000 a year. Fuel prices increased, and other direct costs rose sharply. Direct flying costs for one of the newer planes on a large airline rose from 67¢

*Paper, "Air Transport Problems", was presented at SAE Summer Meeting, French Lick Springs, Ind., June 10, 1948.

per plane mile in 1944 to 87¢ two years later. Everything costs so much more in 1946 that the financing programs the airlines outlined in 1944 became so vast and complicated and so susceptible to upward revision that costly caution and delays were occasioned.

That much is on the record. Something that isn't so evident, however, are the difficulties caused by some of our banking institutions. Carried to the extreme, some evidence occasionally rises to the surface wherein our banks appear to be wanting to buy an expensive coffin for the price of the screws in the lid. They believe in the future of air transportation so strongly that they want to be in control of it. It's somewhat like the case of a young man whose proposal of marriage had just been accepted. "Mary" he said tenderly, "am I good enough for you?" Mary looked John straight in the eye and said. "No, John, but you're much too good for any other girl in town."

Future Planes—How Big?

3. What about future transport aircraft, with regard to size?

While there may be a few technical limits to the size of aircraft, there is a point of diminishing returns, particularly applicable to aircraft where size is a major feature.

Most industry planning along the line has been on a break-even passenger load factor of 60% and other payload of 55%. Experience has frequently shown, however, that these percentages are more likely to be in the neighborhood of 65 and 70% respectively. When these factors come down to a 50% passenger load factor and other payload at a 45% rate—a factor in which plane design plays a great part—with direct and indirect flying costs meeting happily at a much lower level, the industry shall be much nearer maturity and self-sustenance. Also, when one considers other forms of transportation, particularly the rails and buses, we might learn a lesson from them by noting that they chose a multiplicity of units rather than great increases in unit size.

4. Are there any limits to the speed of air transport?

From the engineering point of view there do not appear to be any well-defined speed limits. If, however, you can have breakfast in New York and lunch in San Francisco, or breakfast in Los Angeles and dinner in New York, isn't that fast enough? This is another place where the point of diminishing returns enters the picture. Sonic and transsonic speeds are of much more interest to the armed services than they are to commercial aviation at the present time.

5. What are the solutions to congestion at some of our major airports?

The simplest answer is, of course, more airports. Undoubtedly time will solve this problem and much money has been appropriated by the Congress and by States, municipalities and cities for this purpose. A short time ago, the manager of the Washington National Airport stated that 40% of the landings under instrument conditions there were made by the military services. It seems to me that this percentage is entirely too high at congested airports, if Washington is to be taken as typical, particularly when one considers that as a democratic people we should be primarily interested in utilitarian ideas. The records will show that much of the so-called "stacking" at congested airports is due to our beloved brethren in the military services. Under instrument conditions wouldn't it be far preferable for the military to be required to land at some distant airport rather than delay from thirty to several hundred civilian passengers at a commercial airport? We in commercial aviation owe so much to military aviation that one hesitates to criticize, but from a utilitarian standpoint, more consideration should be given to this subject so that the unpleasant conditions at our congested commercial airports can be ameliorated.

6. Is the air transport industry over-regulated?

My answer is in the affirmative. I feel sure that there should be a reduction, a simplification and a clarification in our present regulations, at the same time shifting some of the responsibility from the government to the airlines.

7. Have you any comment on competition?

We believe in competition, especially under the policy outlined in the Civil Aeronautics Act of 1938, which is designed to develop the scheduled airline industry by promotion of clean and constructive competition. It is the general consensus of opinion, however, that there is in some cases too much duplication in routes, lines and services.

Route Impovements Suggested

8. What can be done about improving route structures?

I fully appreciate that one is treading on delicate ground in making suggestions along these general lines. However, if some such survey were undertaken as the President's Board suggested, I believe both the domestic and international route structures could be improved in efficiency and airline economics advanced in general. Those who sat down to make such a survey and recommendations might well be in the position in which Stephen Leacock, one of our better wits, put himself on occasions when hopeful writers applied to him for advice. He had a stock reply for those who wanted to know how he wrote his delightfully witty paragraphs.

"Why", he would say, "all you have to do is get a pencil and paper and then sit down and write as it occurs to you."

"Yes?" the novice would urge.

"The writing is not hard," Leacock would say, "but the occurring—that, my friend, is the difficulty."

No doubt some toes would be stepped on by a more realistic alignment of routes, lines and services, but a good thing to remember in a case like this is that you can't make an omelet without breaking eggs. A proper Board with proper representation from the interests concerned should be very helpful.

9. What about subsidy?

Payment for service rendered is not a subsidy.

The Civil Aeronautics Act of 1938 defined the manner in which the Civil Aeronautics Board may determine the rate of mail pay to scheduled airlines.

There is a paragraph in a report on Public Aid to Transportation made by the Committee on Interstate and Foreign Commerce of the House of Representatives, which discusses the matter of whether or not there is a subsidy in air mail pay in these words:

"If the CAB properly discharges its satutory functions no mail subsidy accrues to the air carriers or their stockholders; the subsidy is rather to the service or community that fails to provide revenues commensurate with the costs assignable to that service, and a subsidy of that character exists wherever a carrier supports an unprofitable route or service on the basis of earnings accruing from another and more profitable service. If the Board is ineffective in discharging its rate-fixing functions, if the costs of inefficient and uneconomical or dishonest managements enter into the calculation of mail rates, or if the mail rates contribute to excessive earnings, then the carriers are subsidized. Otherwise, it may be said that since 1940, when the CAB began to exercise effective control over mail rates, the subsidy to air carriers in the ordinary sense of the word, does not enter into the mail payments."

Enough said!

10. What about the charge that the airlines are a monopoly?

The word "monopoly" crops up about our industry continually, but without justification.

With 33 scheduled airlines in our picture, how can there be monopoly?

When the Congress adopted the Civil Aeronautics Act certainly no monopoly was intended, for the Civil Aeronautics Board is directed to promote a healthy competition between the airlines to whom certificates were granted on the stipulated basis of convenience and necessity for the public, and toward developing a *sound* air transportation system as an instrument of national policy.

11. Have you any slogan for the air transport industry?

Yes. "Dependability with safety." Our future depends on the degree with which we can provide reliable and safe service at a reasonable cost.

12. Have you any comments on the reports of the President's Air Policy Commission and the Congressional Aviation Policy Board?

Both are excellent. Implementation of the major features of these reports is a necessity. From the manufacturers' point of view a five-year program with the proper changes in procurement laws is probably the most vital part of both reports. From the air transport point of view, the implementation of R. T. C. A. (SC-31)—the program to develop and insure regularity and reliability on the airlines—is probably the most important of their recommendations.

13. What would you consider the greatest hazard under present conditions?

In one word, weather. But I qualify that with the idea that weather is not an aviation problem alone. Weather affects the whole world and is responsible for many blessings as well as troubles. Marked advancements have been make in licking some of these weather problems and it may well be that in the next decade we may not only be successful in solving weather problems from an aviation point of view but also from any other points of view, such as rain-making, guiding or counteracting storms, and other problems now in the experimental stage.

14. What are the general policies of the ATA?

The ATA is:

1. In favor of reasonable competition.
2. Opposed to monopoly.
3. In favor of running our own scheduled certificated aviation transportation business.
4. Opposed to integration with other forms of transport.
5. In favor of Federal regulation, both safety and economic.
6. Opposed to 48-State regulation.
7. In favor of fair and reasonable taxation.
8. Opposed to multiple taxation, including State aviation gas tax.
9. In favor of "patenting" the use of the words, "airlines" and "airliner" to apply only to scheduled air transport.
10. Opposed to travel barriers.

These are considerably shortened in wordage, but they are long in importance. They are, in fact, 10 of the most important things for which the industry, through ATA, is struggling.

May I conclude with a few brief morsels of food for thought:

(a) Travel breeds travel.

(b) Trade breeds trade.

Let's cut down the barriers to both.

(c) How about subways to our major airports?

(d) Where there is no hope of reward and no fear of punishment incentive is lacking and mediocrity results.

(e) Air power is peace power.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

WHAT HAPPENED

at recent SAE National Meetings is told in two articles appearing on other pages of this issue.

WEST COAST Meeting ...... p. 60

TRACTOR and DIESEL ENGINE Meeting .. p. 82

STEERING

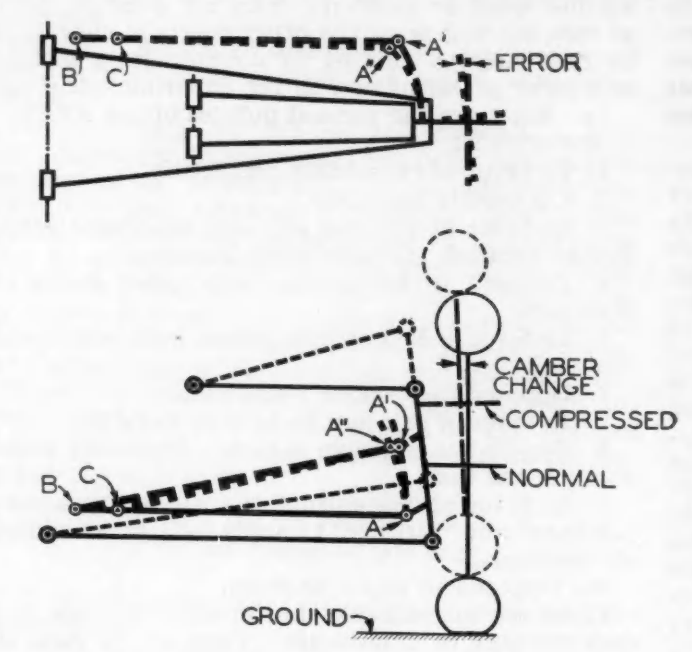


Fig. 1—Steering error produced by spring jounce with an independent suspension

THE passenger car motorist should never be conscious of the vehicle's steering performance. If he is, there is something wrong with the engineer's solution of his part of the problem. Only by observing suspension design fundamentals can the engineer achieve desired performance.

It is generally conceded that independent suspension geometry must be so arranged that there is a minimum of change in tread and that wheel camber change must be held to a minimum in the normal range of wheel travel. These characteristics in an independent suspension can be obtained only by a proper relationship between the steering linkage and the articulating members of the suspension. This condition, of course, prevails on a rigid axle construction; but because of the nature of its design, camber and toe-in in relationship to the road surface (except that caused by deflection) cannot change.

Fig. 1 is a schematic diagram of a typical independent suspension system with rigid top and bottom articulating linkages to control the movement of the front wheel knuckle. The line AB in the lower half of the figure represents a typical reach rod disposition for such a schematic suspension. The point A is attached to the steering knuckle arm and the point B represents a joint in the steering linkage about which the reach rod must rotate in a vertical plane when the vehicle is jounced. Point B, the pivot of the reach rod under jounce conditions, must be very accurately located with respect to the articulating upper and lower support arms, if changes in toe-in and direction of the steered wheels are to be maintained during rebound or compression travel of the front wheel.

The arc AA' indicates the desired path of travel of the steering knuckle arm ball when the wheel is jounced. If the ball can be maintained in this path of travel, no rotation of the wheel in a horizontal plane will occur. This, of course, can only be attained if the point B is at the focus of the path AA'. If the point B were shifted to point C, as indicated, then the path of the knuckle arm and of the reach rod would be indicated by AA". The knuckle arm ball, if unrestricted, would travel in the path AA', but since it is restrained by a fixed pivot at C to travel in the path AA", the interference and resultant steering error is obvious.

Losing Stability

This condition is bound to occur on at least one side of an independently sprung car which has one long and one short reach rod. Such an error or chordal displacement of the steering knuckle arm ball will change toe-in under jounce conditions. However, if the reach rod is misplaced in a vertical plane as well ,then the effect of the camber change would also be noted in toe-in change. Therefore, under conditions of roll, where one side would be in compression and the opposite side in rebound, it is quite obvious that directional stability would be affected.

The importance of the location of these pivot points A and B, as shown in Fig. 1, is illustrated by

GEOMETRY Characteristics

EXCERPTS FROM PAPER* BY

H. E. Churchill

Chief Research Engineer

and

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Experimental Engineer

Studebaker Corp.

the change in toe-in curves indicated in Fig. 2. The change in toe-in curve for car A shows bad interference which produces a total change of 1¼ in. in toe-in from approximately 2½ in. compression to a 3 in. rebound. In other words, 5½ in. of wheel travel produces a change in toe-in of 1¼ in.

These data are taken from an actual independent suspension vehicle in daily use on our highways. The curve indicated for car B shows only about 5/32 in. total change in toe-in for the complete range of wheel travel.

If these data were converted to terms of wheel angularity, car A would definitely show a tendency to self-steer and the degree of self-steering would depend on the angle of roll of the vehicle. Such characteristics produce what is commonly termed as "over-steer" or "under-steer." Extreme over-steering or under-steering is definitely hazardous on curved roads and the hazard increases as car speed goes up. Extreme changes in toe-in also produce rapid front tire wear.

Changes in camber also have a distinct influence on road sense or handling ability of a vehicle. Unbalanced or unequal camber on the two front wheels tends to produce a steering pull or lead, either to right or left, depending on the direction and degree of unbalance. On flat road surfaces the vehicle will usually lead to the side which has the highest positive camber.

Referring back to Fig. 1, the length of the articulating upper and lower arms and the location of the hinges of these arms, with respect to the plane of the wheel and the contact surface of the wheel to the road, determine camber change characteristics due to wheel jounce.

Fig. 3 shows the respective camber changes of cars A and B. It will be noted from the data indicated that car A has an excessive change in cam-

*Paper "Steering Geometry Characteristics and Their Influence on Car Handling," was presented at SAE Summer Meeting, French Lick, June 10, 1948.

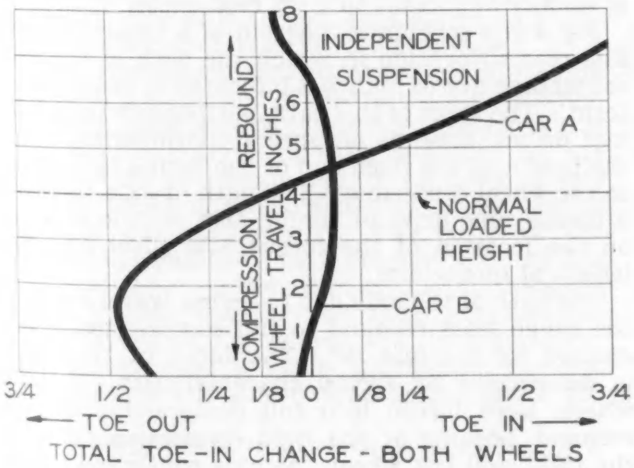


Fig. 2—Toe-in change due to jounce

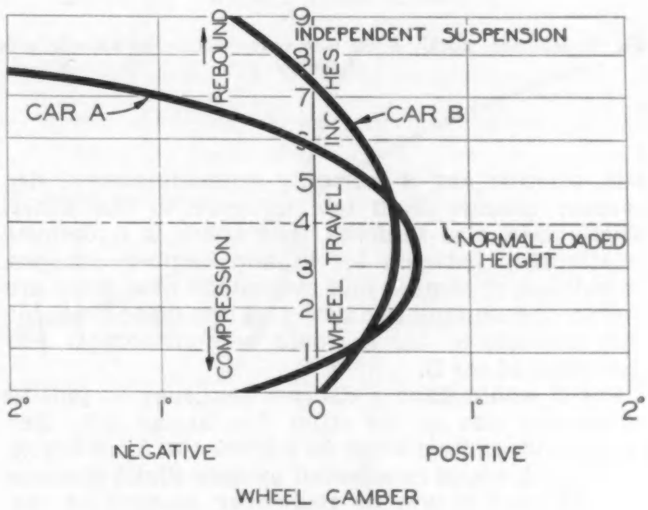


Fig. 3—Camber change due to jounce

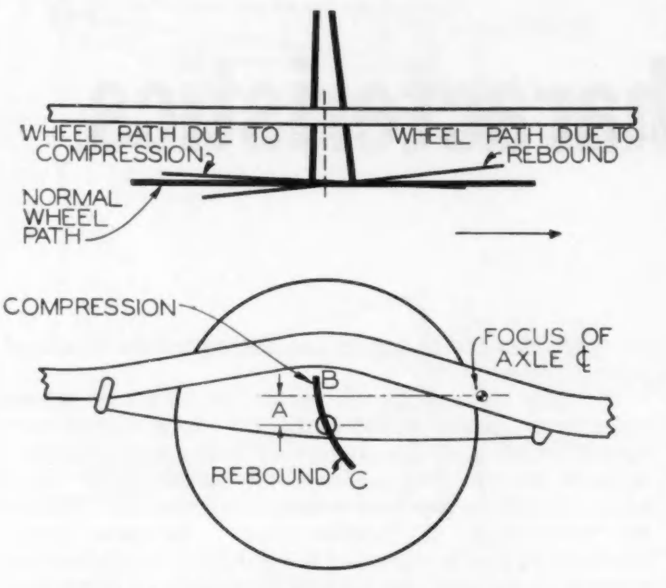


Fig. 4—Rear wheel steering due to suspension geometry

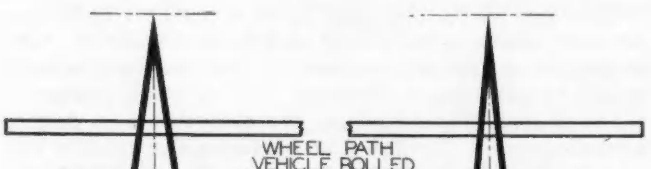


Fig. 5—Maximum shackle effect with spring shackles on opposite ends of springs

ber, whereas car B has only approximately 1 deg camber change from one extreme to the other. These data also indicate that there is a definite relationship between toe-in and camber changes. Unbalance of camber and magnitude of camber are factors influencing tire life; and it is quite probable that tire life of car A would be considerably less than that of car B.

Car A would have a distinct tendency to pull to either one side or the other due to car roll. Because of its acute change in camber the tendency to lead, car A would be affected by only slight changes in load distribution or passenger loading of the vehicle. We are quite sure that the phenomena of "lead" has been observed by all operators; and probably most engineers have observed the change in lead from right to left that can be made by shifting one passenger from right to the left side of the car. It is our opinion that bad camber geometry has as much influence on "lead" as any other design factor.

One other aspect of camber change which deserves study is that change produced by body roll. Independent front suspensions are usually so designed that camber decreases with spring compression. Body roll in turns tends to compress the spring on the outside of the turn and this would tend to decrease the camber of the outside wheel.

However, the camber of this outside wheel is at the same time undergoing an increase due to the body roll itself. With a relatively soft front spring and a suspension showing a small camber change with spring compression, the camber change due to body roll will approach the amount of the body roll. It would be improper to design the suspension so that compression of the spring would give a large wheel camber reduction to compensate for the camber increase due to body roll. Such a condition would increase steering pull or lead with unbalanced loads in normal driving.

Since it is impractical to so design the vehicle that these two camber-changing factors are self-cancelling, some means of controlling the body roll itself is imperative. The introduction of an additional anti-roll agent—such as a sway-bar or the built-in inter-leaf friction of a transverse spring does much to alleviate this condition. However, both of these agents fall short of the ideal since they tend to increase individual wheel rates excessively if they are effective in reducing the roll.

These geometry problems and their effect on steering are accentuated in independent-suspension vehicles. However, the widespread acceptance of independent suspension is ample evidence that its advantages justify the efforts to solve any problems in steering which such suspensions have introduced.

Impression of most individuals operating vehicles on the road is that the steering characteristics of a vehicle are dependent on "goings on" in the front end of the car only. This is an illusion and it has been our experience that proper rear wheel geometry is equally important to good road sense.

Fig. 4 is a schematic diagram of a typical Hotchkiss rear suspension in which the path of the axle center-line due to jounce is indicated in exaggerated form. The focus of this path, particularly in Hotchkiss drives, depends on spring characteristics and the height of the fixed end of the spring in relation to the wheel centerline. The path of axle travel of a torque-tube drive or torque-arm vehicle depends on the location of the torque arm pivot and the length of torque arm.

The path of the axle due to spring travel through the range from rebound to full compression is indicated by the line BC. The focus of this path is determined by spring characteristics. If both wheels were forced into full compression or full rebound, because of the rigid connection between the right and left wheel, the axle centerline would not change angularity with respect to the road, and the plane of the wheels would not change with respect to the longitudinal centerline of the car.

However, if one wheel were forced into the com-

pression position, indicated by B, and the other wheel were forced into rebound position, indicated by C, then the axle would be skewed with respect to the longitudinal centerline of the car and rear-end steering would result. Such a condition of rebound on one wheel and compression on the other is always approached in turning a corner and the degree of roll depends on the angular velocity.

Therefore, rear axle geometry has a very definite influence on "over-steer" or "under-steer." By adjusting the focus of the axle centerline the path of the axle in rebound or compression can be so adjusted as to minimize this steering effect produced by roll. The minimum effect would be obtained if the focus of the axle was at the same height from the ground as the centerline of the axle.

On rigid axle suspensions, the combination of front and rear end geometry can be so adjusted that straight-line steering can be maintained, even under conditions of extreme roll. Fig. 5 illustrates a typical rigid axle suspension system, in which the front spring is shackled at the front end. The curves AB and CD represent the path of travel of the front and rear axles, respectively, due to spring jounce.

Oversteering Occurs

Under conditions of equal compression or rebound on either side and on either axle, directional stability will be maintained; but if the vehicle should be rolled so as to produce compression on one side and rebound on the other, the unequal translation in a horizontal plane thus produced would cause the car to steer to the right, if rolled to the left, or steer to the left, if rolled to the right.

In other words, in making a left-hand curve with such a schematic vehicle, over-steering would result because as centrifugal force tends to roll the vehicle to the right, the angle of turn would be increased. This over-steering due to vehicle roll can be minimized in a rigid axle construction by proper location of the steering reach rod on the front axle with respect to the focus of the axle, and by bringing the focus of the rear axle to the same elevation above the road as the centerline of the rear axle.

Fig. 6 is a similar hypothetical vehicle employing shackling at the rear end of the front spring. When this type of suspension is jounced on the front and rear, the axles describe a path indicated by the lines AB for the front axle and CD for the rear axle because of the symmetrical shackling at the rear of both front and rear springs. The paths of the axles approach similarity and, therefore, vehicle roll produces angular rotation of both axles in the same direction. Thus, angular roll does not increase angular velocity of the vehicle and these geometry characteristics only produce translation sidewise, which would be felt as such during the initial roll only.

The steering effect of body roll, produced by a suspension system as indicated in Fig. 5, is illustrated in Fig. 7. Curve No. 1 shows the angular steering effect produced by body roll in the vehicle as designed and Curve No. 2 the steering effect of the same vehicle as corrected. Both the original design and modification tend to oversteer but, as may readily be seen from the curve, in widely different amounts.

While it is theoretically possible for the engineer to achieve ideal steering geometry characteristics, this rarely occurs in practice. The usual minor compromises necessary on the drafting board may not change the design to any great extent. However, when the car is actually assembled, the introduction of manufacturing tolerances, the use of loose or inefficient linkages and poor maintenance in service may all combine to make its performance far from the ideal.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

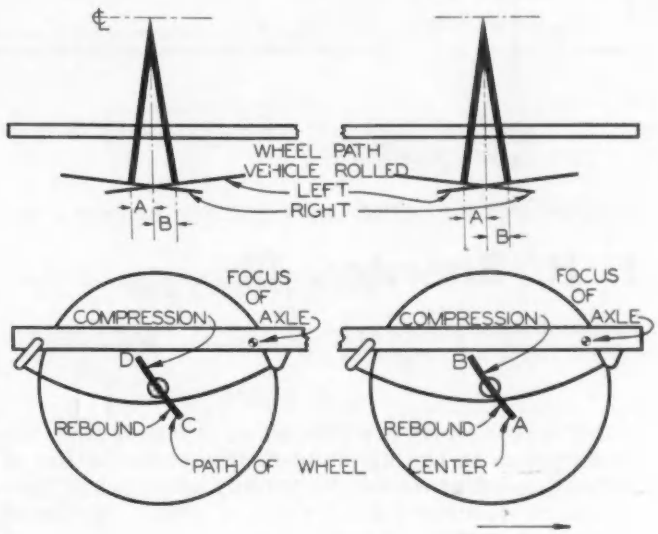


Fig. 6—Minimum shackle effect with spring shackles on same end of springs

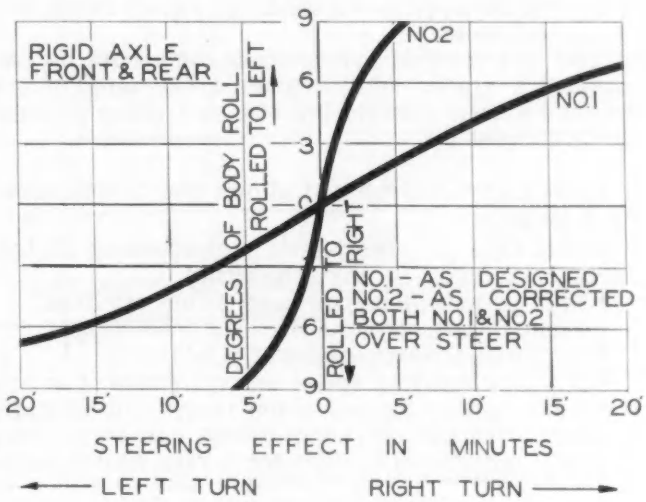


Fig. 7—Effect of body roll on steering

Determination of OPTIMUM

List of Symbols

PL = Payload, lb

K' = Weight of all fuselage items needed to take care of specified payload plus the associated weight-empty items, lb

W_{TO} = Take-off gross weight, lb

α = Thrust specific fuel consumption, lb fuel per lb thrust

β = Powerplant specific weight, lb of installed weight per lb of thrust at any per cent of maximum rating of engine

R = Range, miles

V = Cruising speed, mph

Tr_{av} = Average thrust required throughout entire flight, lb

Tr_{TO} = Thrust required for take-off, lb

BASED ON PAPER* BY

J. H. Brewster, III

Assistant to Vice-President
Fairchild Engine and Airplane Corp.

ONLY a few hours are needed to obtain a first approximation to the airplane-engine combination of lowest takeoff gross weight for any given set of performance specifications, when a newly developed method of analysis is used.

With previous methods such conclusions could be reached only after months of laborious studies and analyses of the performance possibilities of whole families of airplanes of different sizes, having various wing loadings, power loadings, aspect ratios, and so on and so on.

The new method avoids these difficulties by employing a system of nondimensional aerodynamic variables, thus eliminating size and other troublesome factors.

Specifically, the method allows one to determine such items as:

- Best type of powerplant: reciprocating engine, turbojet, propjet, or any other kind.
- Approximate horsepower or thrust required.
- Approximate airplane size and gross weight.
- Optimum characteristics of airplane.
- Limiting cruising speed beyond which it is uneconomical to go for any given range and altitude, so that performance specifications can be written that will remain up to date for a very considerable period. (This item applies only to commercial operations.)

Borderline Cases

Usually, this system results in a clearly defined choice of powerplant type and size. If, however, there appear to be two engine-airplane combinations that have the same take-off gross weight for the same performance specification, it is necessary to conduct the usual cost analysis and to consider the so-called "intangible" factors.

In borderline cases, the intangible factors—which are assumed equal for the first approximation—are:

1. Reliability, durability, serviceability of powerplant.
2. Ease of installation and removal of powerplant.
3. Cabin and exterior noise levels.
4. Vibration qualities of powerplant installation.

Application of Method

Although any set of performance specifications can be used, for the sake of simplicity it will be assumed here that only cruising speed, altitude at which the speed is to be maintained, range, and payload are specified.

The optimum combination of airplane and powerplant for the performance specification being used is the combination that gives the highest value for the factor $(PL + K')/W_{TO}$. Thus, when this factor is as high as possible for a given $PL + K'$, the take-off gross weight will be as *low* as possible.

The $(PL + K')/W_{TO}$ factor can be determined by solving the following equation:

$$\frac{PL + K'}{W_{TO}} = 1 - \alpha\frac{R}{V}\frac{Tr_{av}}{W_{TO}} - \frac{\text{Reserve fuel}}{W_{TO}} - \beta\frac{Tr_{TO}}{W_{TO}} - \frac{\text{Wing + tail weight}}{W_{TO}} - \frac{\text{Landing gear weight}}{W_{TO}}$$

* Paper, "Determination of the Optimum Airplane-Powerplant Combination," was presented at the SAE National Air Transport Engineering Meeting, Kansas City, Dec. 1, 1947.

AIRPLANE - POWERPLANT Combination

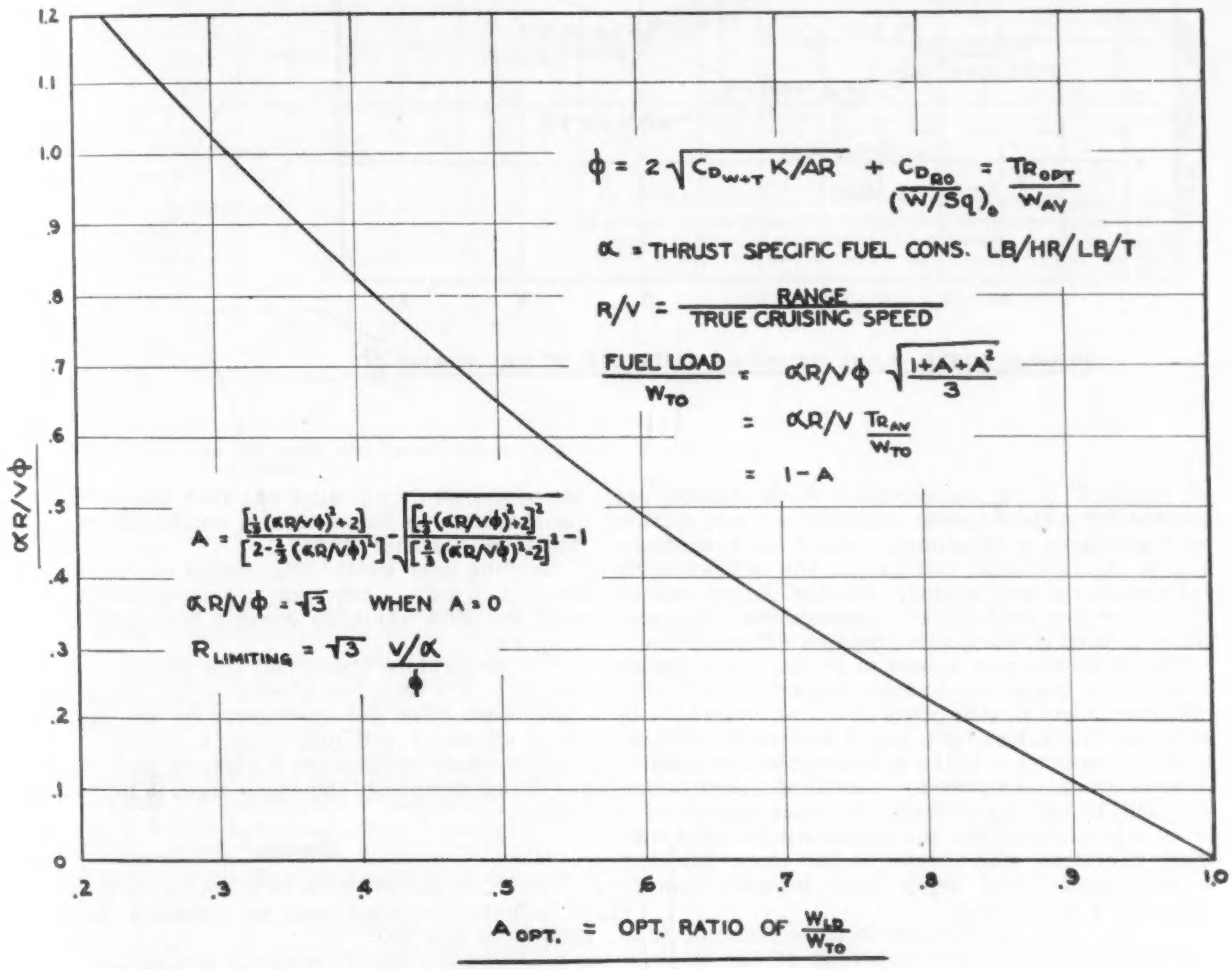


Fig. 1—Determination of optimum ratio of landing to take-off weight—A

If it is considered that no reserve fuel is carried, or if it is carried but not consumed in flight, the term $1 - \frac{\alpha\, R\, Tr_{av}}{V\, W_{TO}}$ is equivalent to A, the ratio of landing to take-off gross weight. The best value for A can be obtained from Fig. 1.

The ratio (reserve fuel)/W_{TO} is the most complicated of all the items to determine, for it depends on the nature of reserve fuel requirements. It can be obtained, if necessary, by methods given in the Appendix of the original paper.

The term β (powerplant specific weight) is obtained from curves of this factor plotted against α (thrust specific fuel consumption) for the types

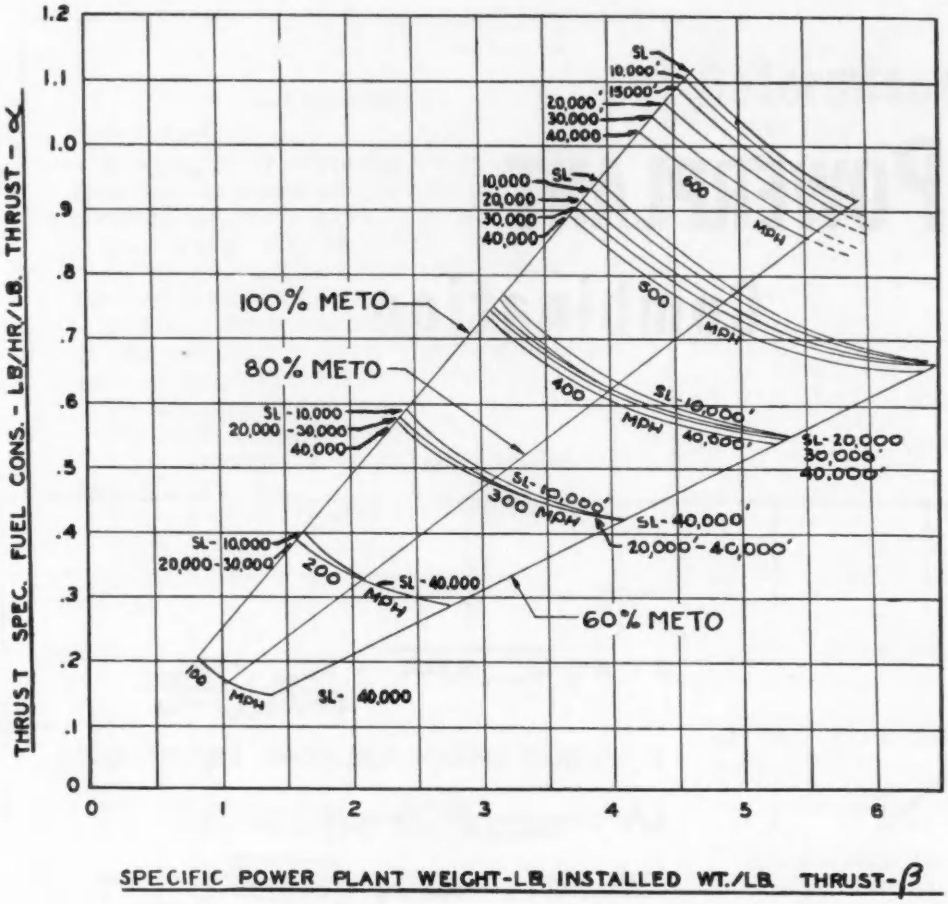


Fig. 2—Typical α-β characteristics of reciprocating, turbosupercharged engines (80% reference propeller efficiency)

of engines being considered. Such curves are plotted for various speeds and altitudes, and at various per cents of maximum rating. For example, Fig. 2 shows typical curves for the reciprocating turbosupercharged engine. Similar curves can be drawn for any other type of powerplant. If a propeller is used a reasonable propeller efficiency is assumed as in the case shown in Fig. 2. As a matter of fact, it is quite easy to make a good guess for the efficiency, even at this point in the analysis and, in any case, the values for α and β will merely change in direct proportion to the correct efficiency, when it is determined. Admittedly, curves of α and β can, and will, be slightly different between engines of a given type and size, but the significant factor is that these functions will always be far more different between powerplant types than between powerplants of a given type.

Tr_{TO}/W_{TO} can be obtained from any one of four expressions given in the Appendix of the original paper.

Fig. 3 shows a typical (wing + tail weight) $/W_{TO}$ chart for commercial transports. Such a graph is sufficiently accurate for initial paper design purposes and can, of course, be refined as much as desired. It should be borne in mind, however, that one only has to get close to the optimum airplane-engine combination on paper. The changes in weight items and drag coefficients of the paper design that will inevitably occur from "jelling" the airplane in detailed design do not alter the fact that a close approximation to the optimum combination can be obtained in a short time.

Landing gear weight$/W_{TO}$ varies consistently between 0.05–0.07. Judgment and experience will dictate the best value to assume for initial design purposes.

The powerplant that gives the highest value for the $(PL + K')/W_{TO}$ factor will be the optimum arrangement. The per cent power for the best operating efficiency will also become evident. If the manufacturer specifies the maximum per cent power for cruise, of course, the upper limit is immediately known.

Results

Two examples will now be given to show the type of information that can be obtained with this method of analysis.

1. Determination of type of powerplant to use for various specified cruising speeds, altitudes, and ranges: As a result of applying the system to airplane-engine combinations utilizing reciprocating engines, turboprops, and turbojets, charts can be calculated which show areas of superiority for the powerplant types chosen. A typical chart (which is independent of payload) is shown in Fig. 4.

With this chart the optimum combination can be determined quite simply. For instance, if a range of 2500 miles and a cruising speed of 350 mph is

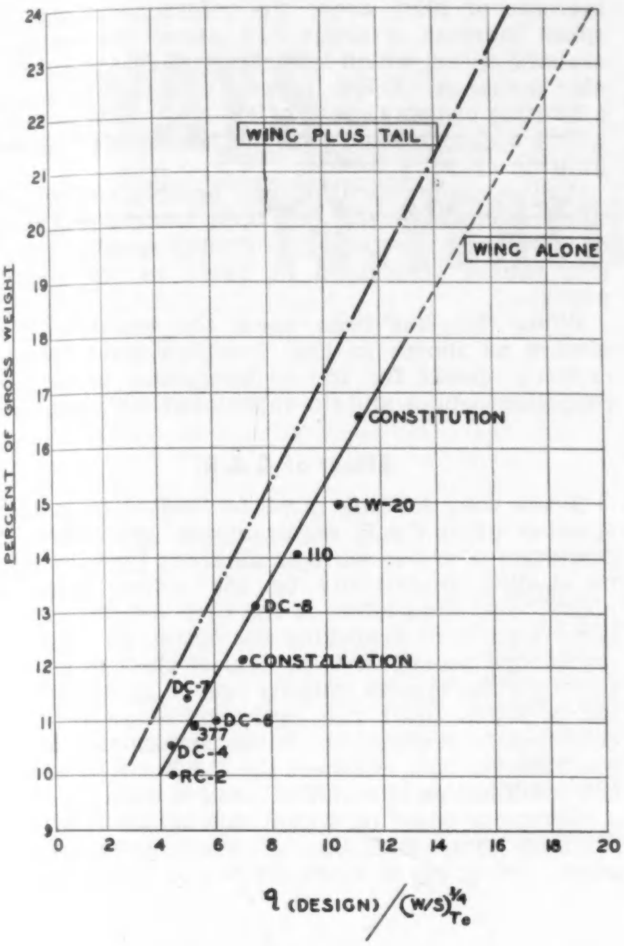


Fig. 3—Variation of wing and tail weight with dynamic pressure and wing loading.

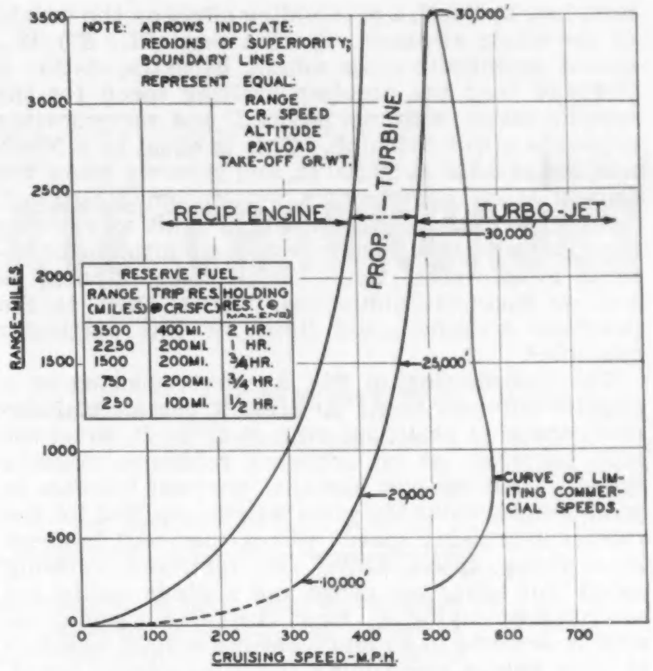


Fig. 4—Optimum airplane-engine selection chart (with holding reserve) Curve of limiting commercial cruising speed for turbojet engine is superimposed on figure to demonstrate that if optimum transports were designed to meet such limiting cruising speeds, they would be powered by turbojets with wide margin of superiority over what could be done with reciprocating engine and turboprop

specified, the chart shows that the reciprocating engine would be best, whereas if the range were only 1000 miles at the same cruising speed, the turboprop would be preferable. The altitudes shown on the graph merely represent logical operating altitudes for the speeds and ranges chosen.

It should be emphasized that entirely different areas of superiority would result if powerplant characteristics, alone, or powerplant characteristics in conjunction with non-optimum airplane characteristics, had been considered. The original paper explains how optimum airplane characteristics are obtained.

2. Determination of limiting commercial cruising speeds: Values of $(\mathrm{PL}+K')/W_{\mathrm{TO}}$ can be plotted against cruising speed, as shown in Fig. 5, which has been developed for a turbosupercharged reciprocating engine operating at optimum per cent of maximum power, 20,000-ft altitude, 2250-miles range, and 10,000-lb payload. It can be seen that as the cruising speed requirements are increased the airplane gross weight increases very rapidly (decreasing $(\mathrm{PL}+K')/W_{\mathrm{TO}}$), since such items as wing weight, landing gear weight, fuel weight, and powerplant weight are all increasing, per se, and each

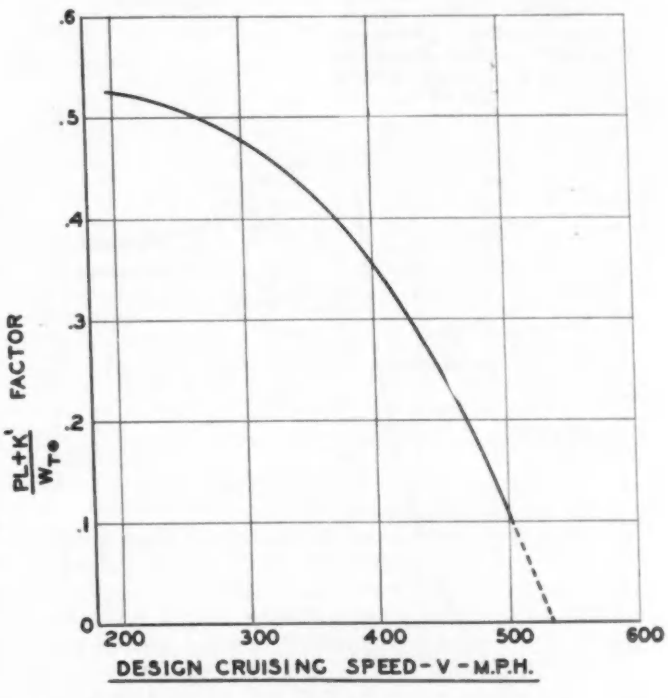


Fig. 5—Typical variation of airplane gross weight with design cruising speed for constant range, payload, and altitude (reciprocating engine, turbosupercharged, operating at optimum per cent of maximum power at 20,000 ft)

item has, by itself, a pyramiding effect on the weight of the whole airplane. Since a zero $(PL + K')/W_{TO}$ means an infinite gross weight, by extrapolation it is found that the absolute limiting speed for the specific range, altitude, payload, and reciprocating engine is about 530 mph. This is equal to a Mach number of 0.725 at 20,000 ft, and is safely below the critical Mach number of a well-designed airplane. Actually, of course, the practical limit in cruising speed is well below 530 mph, since an airplane of infinite gross weight would entail some physical as well as financial difficulties. What, then, is the practical cruising speed limit for this particular example?

The information in Fig. 5 can be plotted in a slightly different form. At present, commercial aircraft cruise at about 300 mph at 20,000 ft, so let 300 mph be taken as an arbitrary reference cruising speed. Then one can plot the "per cent increase in gross weight above the gross weight required for the reference cruising speed" versus "per cent increase in cruising speed above the reference cruising speed" for any given range and altitude—as in the sample given in Fig. 6. From the curve it would not appear sensible to go much beyond a 100% increase in gross weight, since only a slight increase in speed, quite disproportionate to the corresponding weight increase, will result beyond this point. At a weight increase of 100% above the reference weight, the speed increase is about 50% above the reference cruising speed, which is certainly a fair and profitable exchange. A 50% increase above 300 mph gives a limiting cruising speed of 450 mph. This is, then, a first approximation to a method for determining limiting cruising speeds.

A closer approximation can be obtained by considering block speeds and then transferring them back to the corresponding cruising speeds for various ranges (explained in detail in the original paper).

When this has been done, the results can be plotted as shown in Fig. 7, which gives limiting cruising speeds for the reciprocating engine, the propeller turbine, and the turbojet at various ranges.

Effect of C.A.R.

If the wing loading must be limited by landing speed or other C.A.R. requirements, any number of powerplants of the same or different types can still be studied analytically by the system described above. The total effect of the Civil Air Regulations is merely one of modifying the optimum. The recommended procedure is to neglect their incorporation into the system initially and to go ahead with the analysis until the optimum airplane-engine combination is obtained. If the performance of this combination does not meet the C.A.R. requirements, the combination is modified until it does.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fig. 6—Typical per cent variation in airplane gross weight as function of per cent increase in cruising speed at constant range, payload, and altitude (reciprocating engine, turbosupercharged, operating at optimum per cent of maximum power at 20,000 ft)

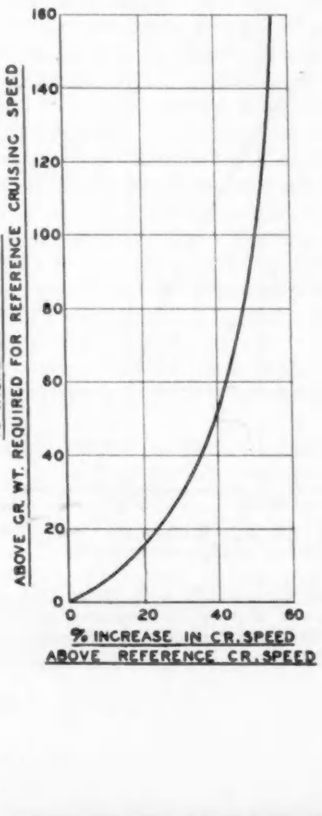
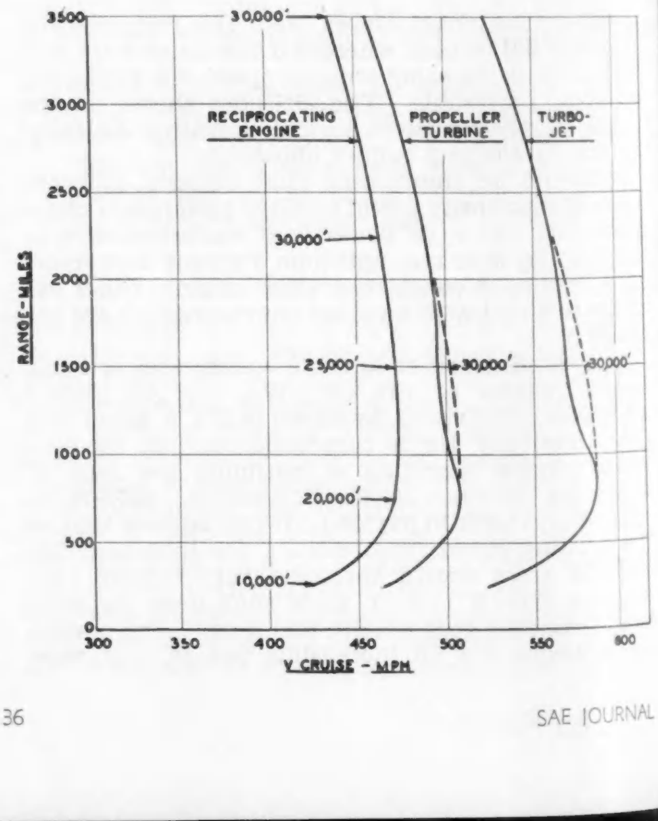


Fig. 7 — Limiting commercial cruising speeds as function of range and powerplant type

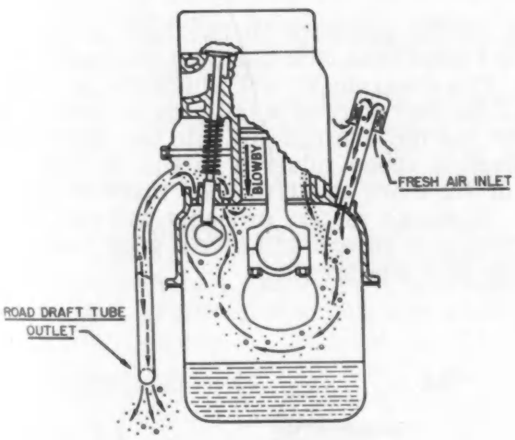


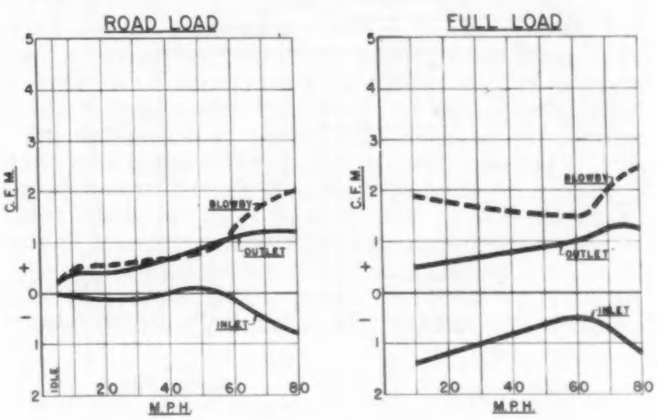
7 WAYS TO VENTILATE CRANKCASES

BASED ON A PAPER* BY **B. Gratz Brown**

Research Engineer, Ford Motor Co.

Positive crankcase ventilation can be achieved in two general ways—by controlling air outlet or air inlet flow. This article describes techniques using both principles, which benefit the engine by getting fresh air to flow through it and by ridding it of blowby gases. (The paper on which this article is based will be printed in full in SAE Quarterly Transactions.)





1. Road Draft Tube:

An example of the outlet control method is the usual crankcase ventilation system with the road draft tube, shown above. This system depends on vehicle speed to create a draft past the open end of the outlet tube, inducing flow out of the engine. Actual road tests of some 1948 cars show many degrees of efficiency of road draft tubes.

Performance produced by a bad installation is shown by the curves. The driver of this car probably noticed fumes at all times, since the inlet flow is negative under practically all driving conditions. (This means blowby fumes are backing out of both the inlet and outlet, preventing intake of fresh air for outlet flow equals inlet flow plus blowby.)

Now turn page for six other ways of improving crankcase ventilation. ⟶

* Paper "Taking the Guesswork Out of Crankcase Ventilation," was presented at SAE Summer Meeting, French Lick, June 11, 1948.

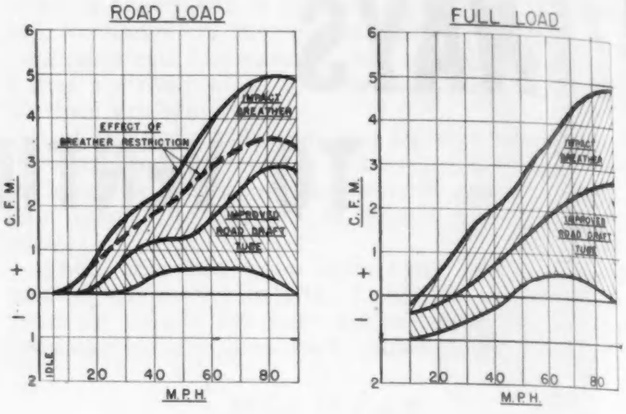
2. Impact Breather:

Incorporating an impact breather will improve the road draft tube system so that it will satisfy average requirements. Inlet flow curves at right show how a poor road draft system can be improved before being released for production.

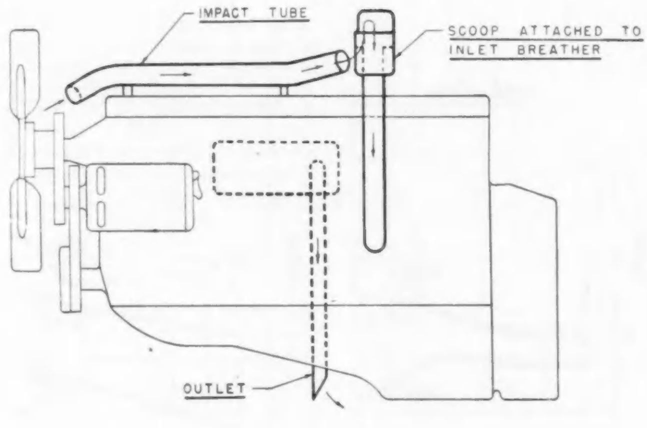
The lower curve shows performance on the car as first designed. Relocating the road draft tube and making it large enough to prevent restriction brought the improvement shown by the middle curve. An impact breather produced further improvement, as per the top curve.

It's usually necessary to provide a definite restriction in the impact breather outlet to limit high speed flow without sacrificing gain at low speed. The dotted curve depicts this effect.

It is possible to determine such performance characteristics for any crankcase ventilation system because instrumentation is now available. For example, flowmeters connected to engine inlet and outlet reveal many interesting effects when driving a test car so equipped. A blowby meter has been made available. It was made especially for use on the dynamometer where its performance is most satisfactory.



Crankcase pressure has been hard to measure in road tests because pressures at other points are changing and a comparative reading cannot be made accurately. For this reason an instrument was designed for setting up a reference pressure on one side of a sensitive differential gage. When testing on a level road, the crankcase pressure is measured with respect to a constant reference pressure.

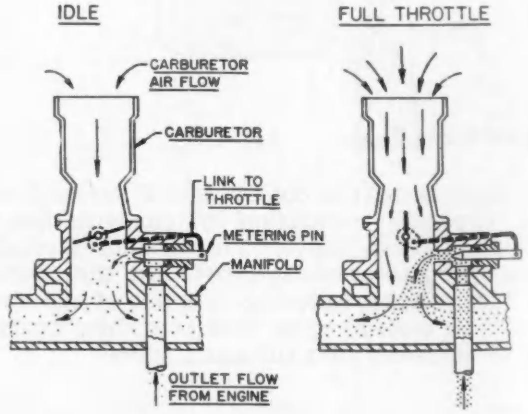


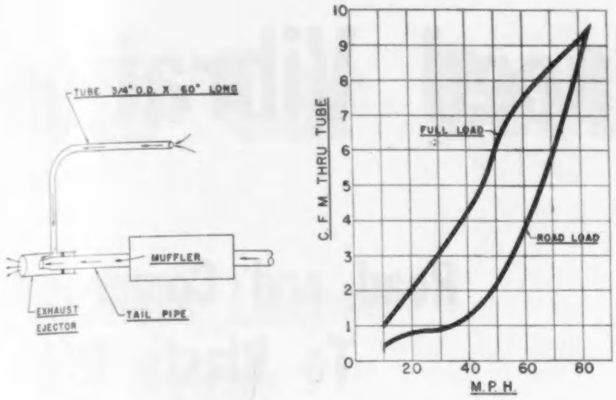
3. Impact Tube:

One of the problems in the field is helping old cars or trucks that lack sufficient crankcase ventilation. The diagram at left illustrates a suggestion for a field fix. Part of a tail pipe is used as a duct so that the fan can ram air into the breather, with a deflecting scoop soldered to the breather. This type of fix lends itself to easy installation in the field. Although meters probably will not be available, pieces of thread will give a good indication of air flow into the breather.

4. Carburetor Metering Valve:

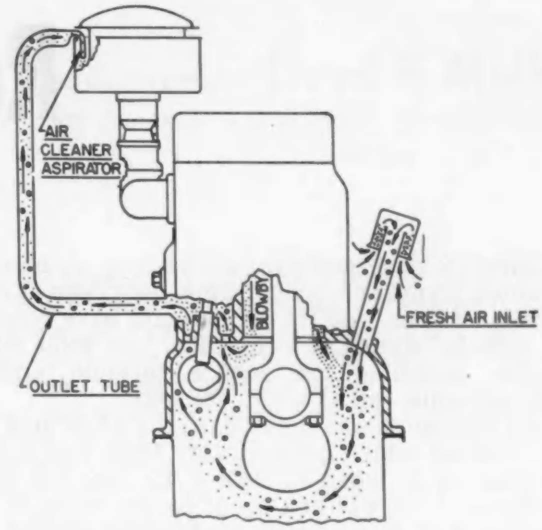
Many attempts have been made to use the manifold vacuum as a means of inducing outlet flow. Because commercial systems didn't give desired results, a system was devised with a metering valve built into the carburetor and connected directly to the throttle lever, as shown schematically at right. This gave much better performance than other types since the off-idle opening was positively controlled. But it had the weakness of all manifold vacuum systems . . . at low speed, full load, the vacuum is not high enough to induce sufficient flow.





5. Exhaust Ejector:

Shown here is the flow obtained with one kind of exhaust ejector. This test was made without the tubing connected to the engine, so that the flow is probably higher than it would have been on an actual installation where the blowby and engine resistance would have effect.



6. Aspirator Action:

A system occasionally recommended involves connecting the outlet to the air cleaner, using aspirator action to induce ventilation. This is diagrammed above. The system depends on engine speed and load, but can produce satisfactory ventilation.

7. Motor Blower:

The systems so far shown control outlet flow and are susceptible to plugging or gumming from the outlet gas. This has seriously handicapped air cleaner aspirated and manifold vacuum systems. And plugging affects road draft tubes if the tubing is too small in diameter. Additionally, none of these systems are really positive and completely independent of speed and load.

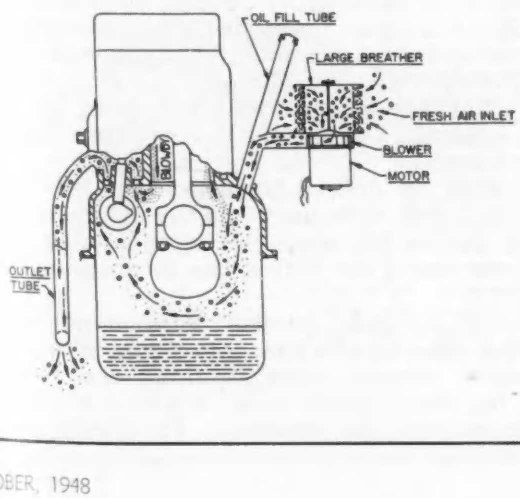
A system that controls inlet flow, it appears, will more nearly provide a constant amount of fresh air. Reason: it will eliminate harmful effects of outlet gases as the control means and blowby will have less effect.

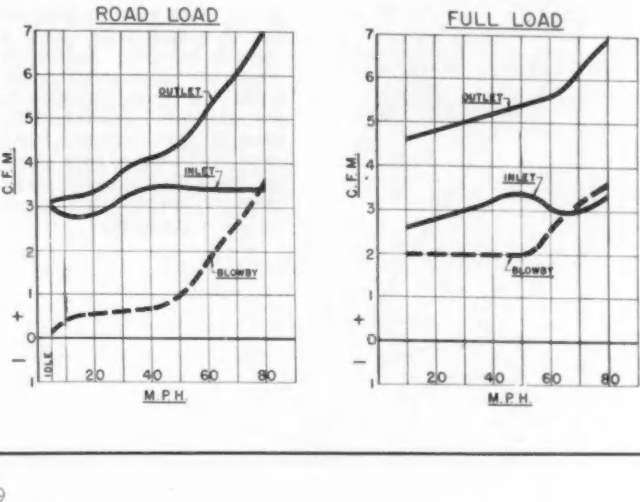
The schematic diagram below shows such a system, using a specially-designed motor blower on the inlet. The small motor blower runs whenever the ignition is on and forces a constant flow of fresh air into the engine inlet. A large capacity breather is needed to remove the dirt since the average flow is much higher and the normal size breather plugs up too quickly.

The outlet is an unrestricted tube with an oil separator or condensor. It can be located in the road draft to help overcome the greater engine restriction and blowby at high speed, and to exhaust outlet fumes where they will not be objectionable.

By determining engine resistance to ventilation flow, it is possible to design a quiet, compact, low-speed motor blower that will provide almost constant fresh air inlet flow at idle as well as at all vehicle speeds, as shown by the curves below.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)





Reduced Vibration

Road and Component To Blasts Which

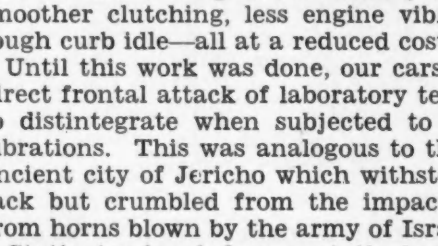
EXTENSIVE static and dynamic tests on automobile frames, frame and body, frame, body, and engine, the complete car, and its components have resulted in a vehicle having no car shake, less road noise, smoother clutching, less engine vibration, and no rough curb idle—all at a reduced cost.

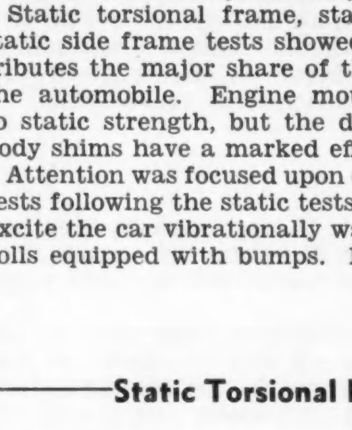
Until this work was done, our cars withstood the direct frontal attack of laboratory tests, but tended to distintegrate when subjected to constant road vibrations. This was analogous to the walls of the ancient city of Jericho which withstood frontal attack but crumbled from the impact of vibrations from horns blown by the army of Israel.

Static torsional frame, static beam frame, and static side frame tests showed that the sedan contributes the major share of the overall strength of the automobile. Engine mounts contribute little, to static strength, but the design and location of body shims have a marked effect.

Attention was focused upon dynamic or vibrational tests following the static tests. The first attempt to excite the car vibrationally was to run in on chassis rolls equipped with bumps. But it was soon found that the problem was far too complicated to be solved that way.

Static Torsional Frame Test





Although static strength is not the final answer to car shake elimination, frames of various makes were tested torsionally. Load was applied by weight B through lever A. Deflections were recorded at several points along both sides of frame by dial indicators. Marked difference is seen between frame alone and frame and body, showing that body contributes major share of overall strength of vehicle

It was found necessary to break the problem down into its components, and to excite individual units.

The compilation of the frequencies shown in this series of tests showed that certain masses in the experimental cars resonated with each other and produced objectionable shake.

This led to the decision that the key to most of the problems involved in unsynchronizing the frequencies of these various masses was to be found in engine mounts.

Controlled frequency engine mounts used in 1948 production cars are designed in such a way that the frequency of the engine in any one of its planes of vibration does not synchronize with the frequency of any other part of the automobile. This prevents shake, clutch chatter, engine torque reaction periods, and other disturbances.

We approached the engine mount problem as though we had never heard of such devices. Solid all steel mounts were tried first, and then the rate of frequency was reduced by use of rubber until the fantastic static deflection of two inches was reached.

Location and frequency rates were then calculated from road observations and laboratory frequency tests. Natural rubber of 45 durometer and a 50 durometer GR-S synthetic had proved themselves, and these materials were standardized upon.

A survey of satisfactory existing mounts indicated that 25 psi in shear, and 50 psi in compression would be satisfactory. A minimum adhesion of 300 psi was found adequate.

Knowing the location and weight to be carried by the mounts, the surface support area was easily determined.

Knowing the desired frequency, the type of rubber or synthetic to be used, and the weight to be supported, rubber thickness can be calculated readily. Thus the size of the mount can be accurately forecast.

In any vibration control work frequency and damping are basic factors. Most engine mount development stopped after reaching the frequency stage, but development of better ride continued and progressed into the damping. The shock absorber

Cuts Car Cost

BASED ON PAPER* BY **Lloyd E. Muller**
Staff Engineer, Buick Motor Division, General Motors Corp.

Roughness Likened Felled Jericho

was developed and used to control the amplitude of the spring oscillations.

The hysteresis of the synthetic rubber in the mount and the rate of the mount under actual load can be evaluated with the Buick engine mount tester which was developed for this purpose. This stroker machine has an electronic strain recorder and a photographic recorder. An asbestos lined heating box is used for endurance and elevated temperature (100 F) tests.

Constant temperature, constant speed, and endurance tests are recorded to determine compression, tension, or shear loading. The machine shows accurately the point of failure, a most important determination. A camera makes a permanent record of the oscillograph images in life size photographs.

Because the machine tests the actual mount, it may be used for inspection and production control.

Torque tube drives complicate engine mount problems, but this form of drive ties the engine mass to the rear wheels and provides a weight in proportion to the drive forces generated by the rear wheels. This added mass effectively lowers the cutoff frequency and produces a smoother ride with less shake, vibration, and wheel hop, due to the proper control of the rear wheels by the engine mounts.

Clutch chatter vibrations synchronize with the body-frame-engine frequency. If the natural frequency of this combination is sufficiently different from the clutch chatter frequency, the clutch will not excite the car and a smooth clutch engagement can be had with no changes in the clutch itself.

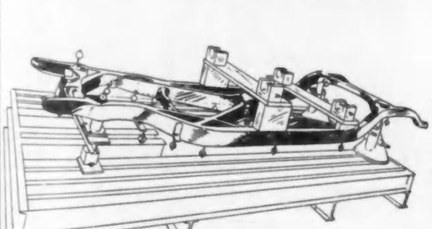
Engine torque reaction is the result of the resonance frequency of the engine-frame-body structure being within the engine's firing frequency range. If the resonance frequency of the structure is sufficiently removed from that of the firing range, customary torque reaction periods will be eliminated.

Briefly stated, the engine's resonance frequency, when mounted, should be less than the frequency to be isolated.

Following static tests on frames and frames mounted with bodies, amplitude of motion of engine

* Paper "Walls of Jericho" was presented at SAE National Passenger Car and Production Meeting, Detroit, March 5, 1948.

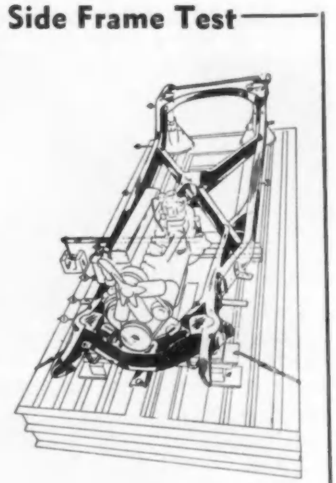
Static Beam Frame Test

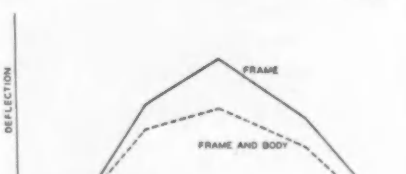


← Frame held at all four spring seats and load applied at passenger seat locations. Dial indicators along each side rail and at center of X member again shows contribution to overall strength made by body. Engine mounts have little effect on strength, but design and location of body shims have marked effect on overall vehicle strength

Static Side Frame Test

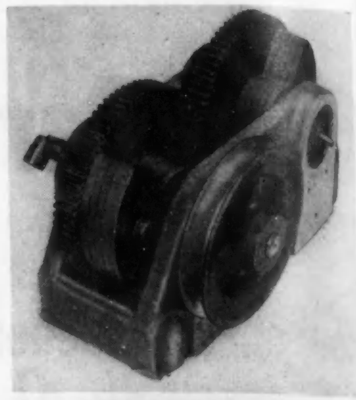
→ Frame held at the four spring supports and is loaded by bell crank force of which is transmitted to frame by the engine mounts because all rear wheel loads are transmitted to chassis through mounts because of torque tube drive. Comparison is clearly seen between frame alone and frame and body of automoble





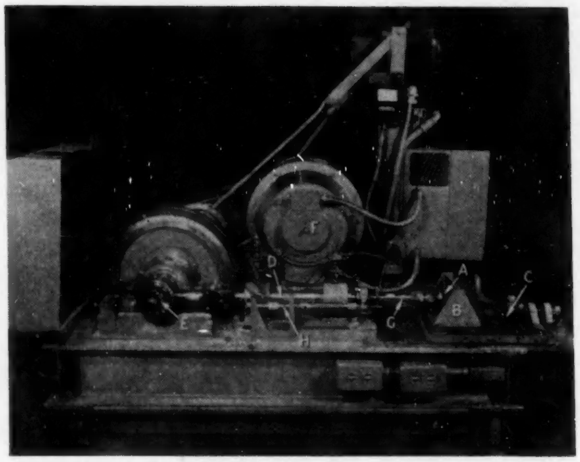
was tested in a chassis roll equipped with bumps. This was unsatisfactory because of the complexity of the problem. The exciter (right) excited components individually. The engine mount test machine (below) evaluated factors controlling vibration.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

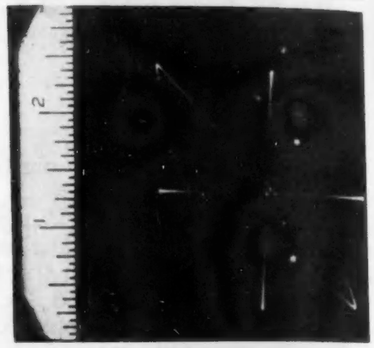


→ Vibrator consists of two flyweights geared together to produce opposite rotation and a straight line force. Can be attached to engine, torque tube, rear axle, and almost any other component of car

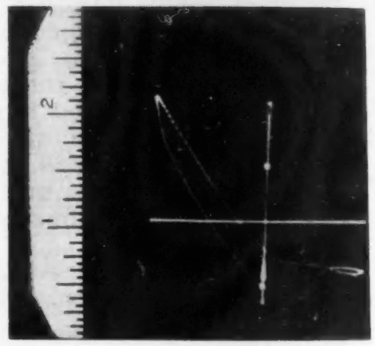
Test Equipment



↑ Engine mount test machine composed of mechanical stroker (above) electronic strain gage recorder, and photographic recorder to record hysteresis of rubber or synthetic and rate of vibration of actual engine mount. Mount on bracket B bolted to plate C. Loading actuated through reciprocating rod D by crank at E. Motor at F. Strain gages cemented to load recording tube G. Corresponding stroke recorded by strain gages on tube H

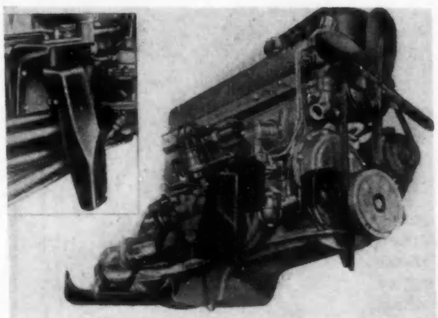


→ Cathode ray image with test machine in motion

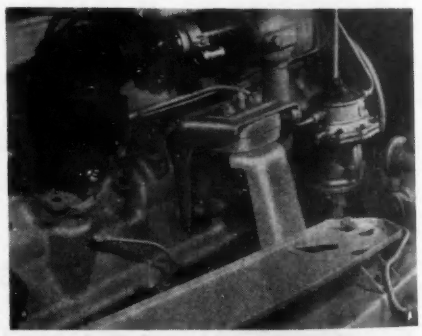


→ Typical image when broken engine mount is tested under compression-tension conditions

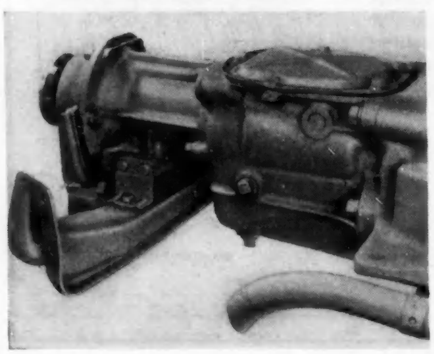
Engine Mounts



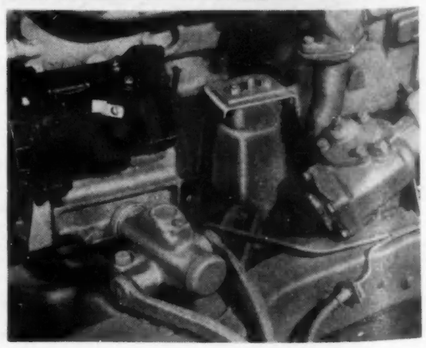
← Buick controlled frequency engine mounts developed from study of test results



→ Closeup view of rear mounts, one of the keys to solving problem of vibration



← Closeup view of rear mounts being used in the 1948 production automobiles



→ Left front Buick engine mount which helps to unsynchronize various frequencies of components

HOW TO BRING TOGETHER DIESEL FUEL and AIR

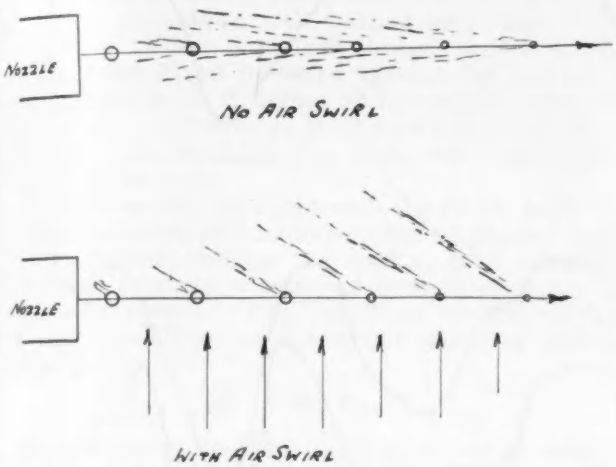


Fig. 1—How air swirl promotes better combustion of diesel fuel

BASED ON A PAPER* BY

C. B. Dicksee

Research Engineer
Associated Equipment Co., Ltd.
Southall, England

(This paper will be printed in full in **SAE Quarterly** Transactions)

GETTING air to fuel, fuel to air is the two-way street to greater diesel engine efficiency. Proper air swirl and fuel penetration promote much-desired rapid and complete combustion.

The principle of air spinning or swirl, first demonstrated by Ricardo, calls for orderly air rotation past the nozzle which injects diesel fuel at right angles to the air stream, and at the proper rate. By adjusting the air's rotational speed to suit the engine and then matching injection rate to swirl speed, combustion can be confined to that part of the cycle producing maximum efficiency. At the same time maximum pressure can be controlled.

Introducing fuel at right angles to the air stream gives individual droplets a much greater chance to meet oxygen molecules necessary for their combustion. Combustion products are carried away by the air stream, out of the path of succeeding droplets, rather than each droplet following the same path through the air as its predecessor. See Fig. 1.

For an open combustion chamber, swirl is produced during the induction stroke. In latest designs, it is augmented during the compression stroke by transferring air from the cylinder into a combustion chamber, smaller in diameter than the cylinder.

Delivering the air tangentially—with either a directional port or a masked valve—produces the swirl. Although the directional port currently is receiving more attention the masked valve looks more desirable because of its flexibility. With it, swirl can readily be changed by adjusting the mask position. This is especially valuable during development since the swirl can be varied at will, optimum value for any given combustion chamber quickly and easily determined. By arranging the inlet valve to rotate while the engine is running to shift the mask to a new position, effects of a change in swirl are instantly determined.

Our procedure is to start with too large a mask that will produce over-swirling; by rotating the valve through a full circle, we note the effect on dynamometer pull. Over-swirling produces four distinct peaks, Fig. 2, with valleys between over-swirl and under-swirl. The process is repeated at several speeds; and the mask then is cut down in

* Paper "The Open Combustion Chamber Automotive Diesel Engine in Britain," was presented at SAE Metropolitan Section, New York, Dec. 17, 1947.

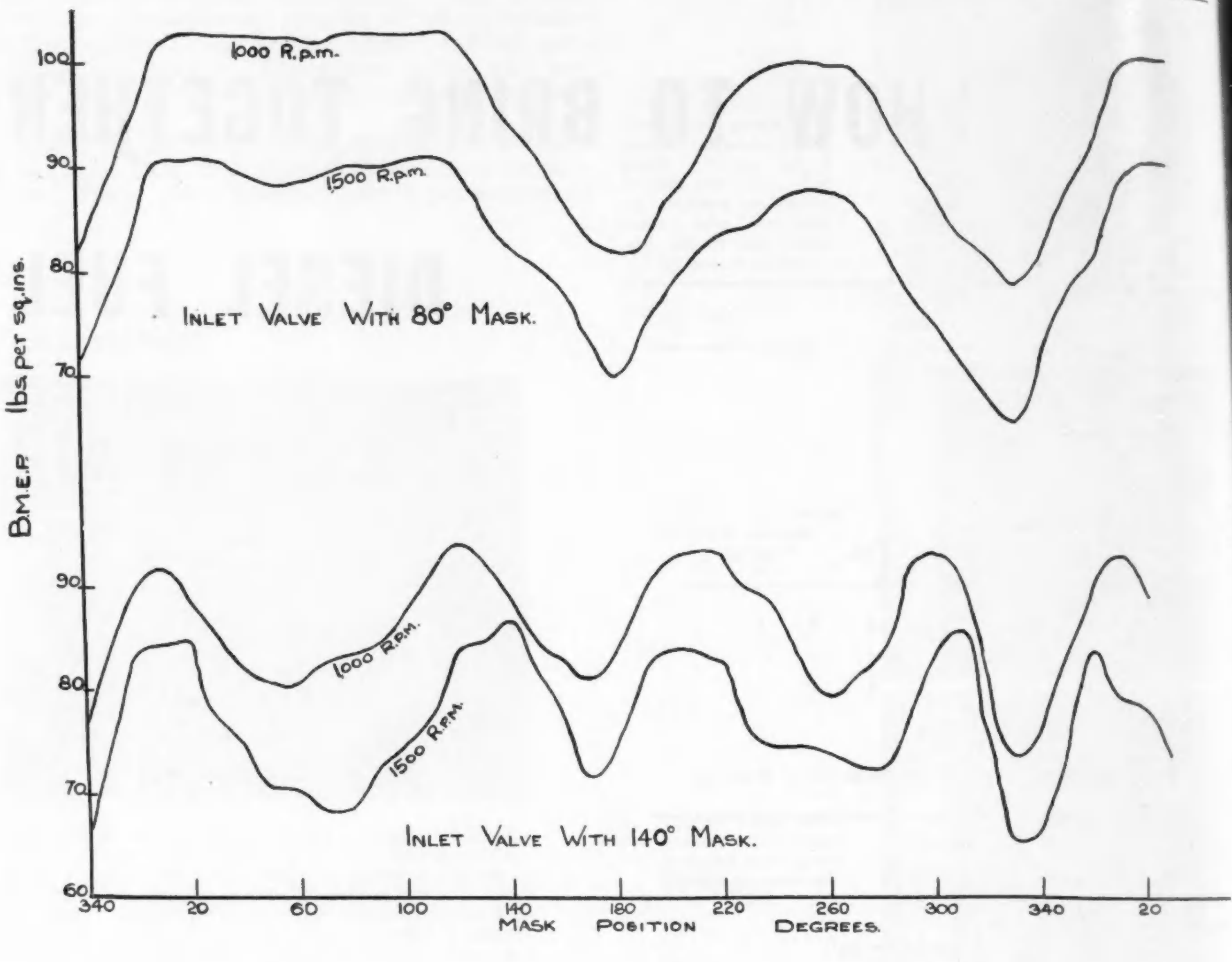


Fig. 2—Data assembled in finding best mask for inlet valve of diesel engine. Lower set of curves depicts mask producing over swirling, upper set represents proper valve mask size

stages until the plotted results produce two humps with a wide flat top indicating that the position of the mask is not critical.

In this way it isn't hard to find a position suiting all speeds within the engine's range.

Locating Valves

Fig. 3 shows the valve and the method of locating it—a thimble which slips over the valve guide and engages it with a spline on the valve stem. The thimble is located by a dowel and is easily removed for valve grinding. When in position it is held down by the inner valve spring.

Some argue against the masked valve by saying that it affects volumetric efficiency. But if it produces the same directional effect as a directional port it presumably has the same effect on volumetric efficiency. Actually with masks of the size we have found necessary—60 to 75 deg of valve circumference—we have not detected any influence on volumetric efficiency.

With a directional port you are saddled with a fixed swirl and must find a combustion chamber to suit it; you cannot readily adjust the swirl to suit any combustion chamber, as with the masked valve. Changing the swirl calls for a new cylinder head.

Big difference between diameter of the cylinder and the combustion chamber bears significantly on engine performance. The compression stroke transforms air from a rotating mass, with a diameter of the cylinder, into a mass with a smaller diameter-equal to that of the combustion chamber. Theoretically this increases rotational speed in proportion to the squares of the two diameters so that a much smaller swirl rate need be developed during the suction stroke.

But in the engine, considerable losses accompany the transfer; actual increase in rotational speed is much less than theoretical. Ratio between the

two speeds seems to be more nearly directly as the two diameters. Reducing to a minimum the clearance between cylinder head and piston at top dead center transfers the maximum possible quantity of air to the nozzle region. At the same time it builds up swirl speed to a maximum during the injection and combustion period.

Final action of squeezing the air out from between the piston and cylinder head is known as "squish." Fig. 4 shows the air's path in traveling into the combustion chamber. Increasing rotational speed toward the center is indicated by the tightening spiral in which the air moves inward.

In addition to rotary movement of the air, there is also an important, well-defined secondary motion. It is rather complex, caused by frictional effects. Centrifugal pressure against the combustion chamber walls is higher at the middle than at the two ends, so there is a flow outward toward the two ends. On reaching the ends, the fluid flows inward across them.

This movement, combined with the rotary motion, produces a double helical movement across the face of the cylinder and up the center, with a spiral movement inwards across the ends, and outward across the center. The resultant double vortex movement produces an actual air track, as shown in Fig. 5.

Job of the Fuel

Making the air look for the fuel does not relieve the fuel of any responsibility. The fuel must get away from the nozzle and out into the open, where the air can get at it. It should be given sufficient penetration to travel right across the air stream and reach the far side. At the same time the fuel should break up to give a large surface-to-volume ratio, with wide lateral distribution, to induce rapid burning.

Giving the fuel just the right degree of penetration means it must just reach the far side of the air stream, no more. Fuel particles should complete their combustion as they reach the far cylinder wall. Failing to reach the cylinder wall wastes much of the available air; throwing the fuel on the wall renders it unsuitable for clean, rapid combustion. Some fuel may be thrown back again into the air stream after striking the wall. But it would be dangerous to rely on this since the particles will have lost most of their speed after traveling so far and the energy remaining would be low.

Admittedly some of the fuel does reach the far wall—as marks on the piston show—and the engine doesn't seem to suffer any serious inconvenience. The marks probably are made by an occasional heavy particle. If the surface against which they strike is hot enough, it will not be wetted; the particle may then be swept away by the air stream and given another chance to make good. If the particle has enough energy to break up on impact with the wall, it helps this action considerably.

Fineness alone is not enough to make a spray suitable for diesel engine work. For this reason the wonderfully fine sprays produced by centrifugal sprayers are useless because the widely-dispersed spray lacks energy to give it penetration and to get it away from the nozzle.

Air density within the combustion chamber is high—about 1 lb per cu ft. It takes a lot of energy to penetrate it. Providing adequate penetration rather than preventing over-penetration is the real problem. It calls for a hard spray—the kind you can get only from a nozzle with one or more small drilled holes from which the jet emerges at high speed.

Effective atomization is a must under all load and speed conditions for low fuel consumption and clear exhaust. With a simple drilled hole there is no atomization within the nozzle itself; it stems from the reaction between the high-speed jet of fuel and the air through which it travels. Spray production mechanism is the friction between the jet and the air. Only when the jet reaches a certain speed does the process become fully effective. Once reached, this speed induces rapid break-up. But the necessary velocity must be reached right at the start of injection.

For this reason a closed nozzle fitted with an inwardly opening differential needle valve, is used. This permits high pressure build-up in the fuel,

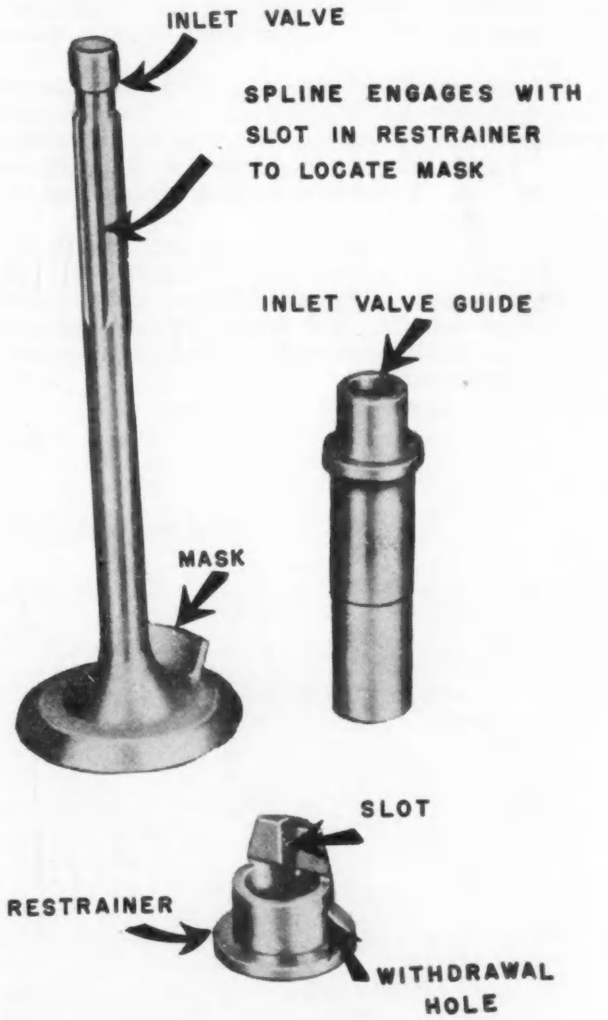


Fig. 3—Masked valve and locating equipment

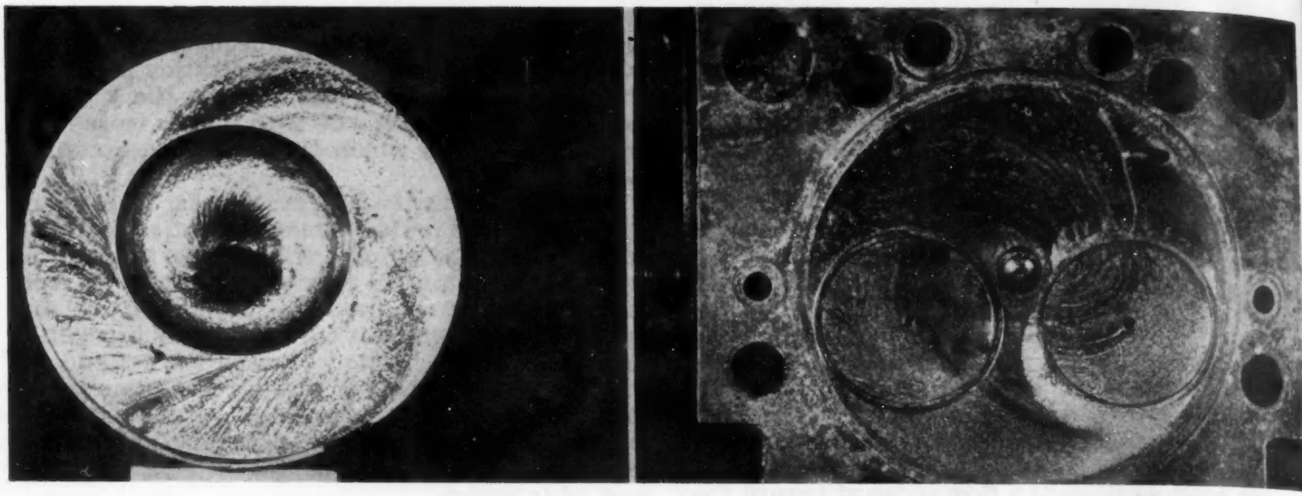


Fig. 4—Path traveled by air when squeezed from between piston and cylinder head into combustion chamber

before start of injection, which is applied suddenly to the orifice when the valve opens. Thus the fuel jet head leaves the nozzle with enough speed to atomize.

The air swirl little deflects a hard spray, as shown by marks left by the fuel on the far combustion chamber wall. These marks are always directly opposite the holes in the nozzle. Aside from some fanning out, the spray can be considered to travel in a straight line.

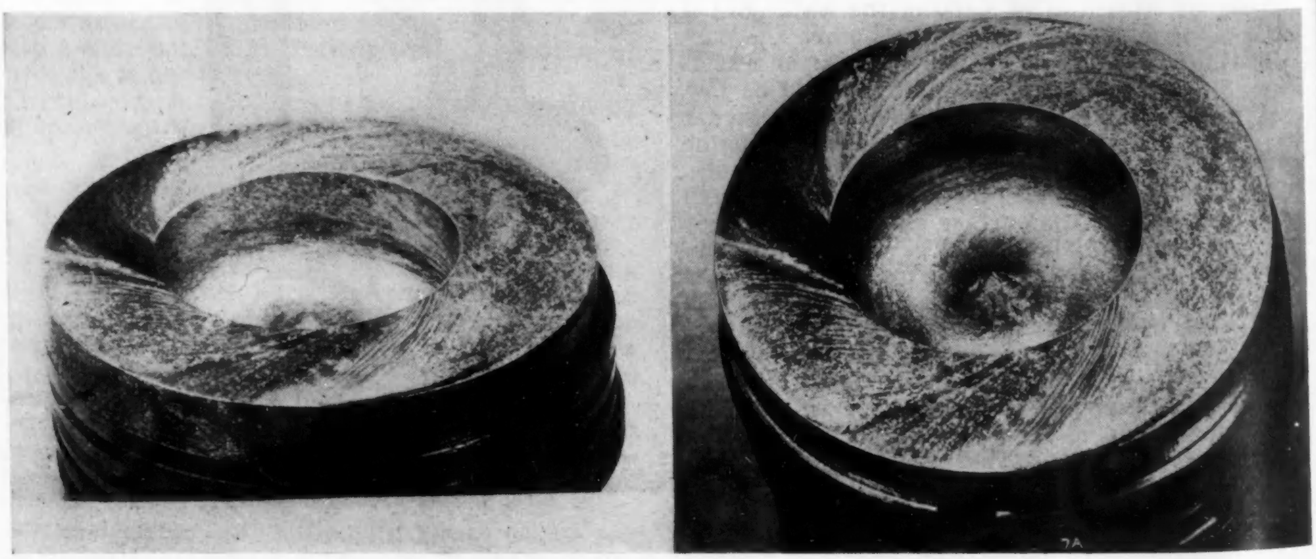
Nozzle hole size directly influences length of injection period. The smaller the hole for a given fuel delivery, the higher the pressure and the greater the compressibility; the larger the hole, the lower the jet speed, the coarser the spray, and the greater the penetration.

Number and size of holes for different engines vary suprisingly little. With but one exception, we use four holes. While in theory the number of holes is a question of adjusting the swirl, we don't get anything close to the results of a four-hole nozzle with either three or five holes.

We use hole diameters of 0.010 and 0.25 mm. (The difference is infinitesimal.) We found that the same nozzle does duty for four different cylinder sizes varying from 70 to 100 cu in. Length of hole has little bearing within wide limits, according to tests with holes varying from 0.4 to 1.25 mm (1.6 to 5 diameters).

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fig. 5—Air travels helically over combustion chamber wall and spirally across the bottom



IGNITION THEORY

Uncovers Electrical Design Facts

How molecules of the fuel-air charge get hot enough to burn and how they release energy to power the internal combustion engine are discussed here by Cipriani and Middleton. They also tell how these theories pay off in electrical equipment development.

This is just part of modern ignition physics reviewed by the authors in the paper on which this article is based.

EXCERPTS FROM PAPER* BY

C. Cipriani

Senior Engineer, Spark Plug Division

and **L. H. Middleton**

Vice-President, Engineering
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IGNITION of an air-fuel mixture by an electric spark continues to be one of the most nebulous and least understood phenomena of the internal combustion engine art. But light continues to be thrown on fundamentals, such as combustion and ignition mechanisms, which is furthering development of ignition equipment.

Mechanism of Combustion

Combustion of even the simplest hydrocarbon in the gaseous state is an immensely complicated process involving chain reactions, chain branching, chemical equilibria, unstable intermediate products, active atoms, ionic compounds. Perhaps the most remarkable thing about the process—practically regardless of how it starts or by what path it proceeds —is the end result; so far as heat output is concerned, it is identical.

Much attention has been given to combustion in engines at or near wide open throttle in the quest for higher engine power, but comparatively little attention has been paid combustion at small throttle openings, where, at least in passenger cars, 9 out of every 10 gal of fuel are consumed. We believe this situation must be remedied in the near future in the interest of tank mileage, which is becoming increasingly important as fuels rise in cost.

Can the ignition supplier play any part in increasing tank mileage? We believe he can, by recognizing the fundamentals of combustion. For instance, it is known that nascent oxygen, O_3, is generated by electromagnetic radiations. It is also known that oxygen in this activated form is productive of a more rapid combustion at a given temperature. Obviously, then, an ignition system which, by virtue of its transient phenomena can produce O_3 copiously, is a step in the right direction.

Such an effect would be particularly noticeable at small throttle openings, when all of the additional spark advance required, as compared with full throttle, is necessary to compensate for ignition lag in the first 10% of the flame travel.

Combustion, especially at part throttle, can accurately be regarded as a heat transfer problem between a sphere or cylinder of burned mixture at high temperature and an encompassing turbulent, heterogeneous mass of unburned mixture at low temperature.

For the reaction to proceed at all, it is necessary that the temperature within the sphere or cylinder never decrease; and work is being done continually by the expanding sphere or cylinder in pushing back the unburned mixture. It will be evident that particularly during the early stages of ignition and propagation, a surface-to-volume ratio between burned and unburned mixture favorable to reduced heat transfer will be desirable. For this reason increased spark plug gap settings are conducive

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* Paper "A Modern Approach to Ignition," was presented at SAE Summer Meeting, French Lick, June 10, 1948.

toward the ignition of lean mixtures, as are electrodes of small mass and high temperature, located as remotely as possible from any surfaces which might detract from the heat content of the initiating sphere of burned mixture.

Oxidation of multi-atomed hydrocarbon molecules never takes place in such a manner that the end products are formed immediately. Therefore, a combustion equation (as shown below) is completely misleading unless it is understood that, for purposes of convenience, oxidation of the intermediate products has been omitted.

$$C_8H_{18} + 12.5\,O_2 \longrightarrow 8CO_2 + 9H_2O$$

If oxidation were to take place directly without the formation of intermediate products, the above equation would mean that in a gaseous state, one molecule of C_8H_{18} would have to be in collision with 12.5 molecules of O_2, at the same time and with the same activating energy. Obviously such is not likely to be the case, and in reality it is practically certain that the first reaction will be between one molecule of C_8H_{18} and one molecule of O_2.

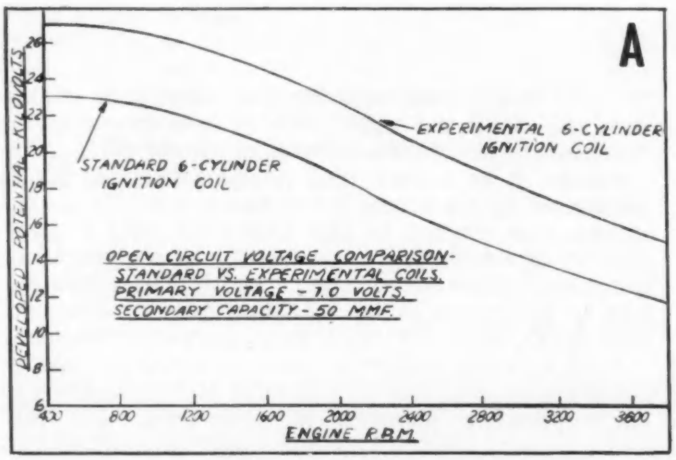
According to the kinetic theory, the molecules of C_8H_{18} and the molecules of O_2 impinge on each other and on the walls of the containing chamber, at high velocity and with perfect elasticity; and for a chemical reaction to occur, the kinetic energy released upon impact must be sufficient to break the bonds of both of the impinging molecules.

If the reaction is to continue, the energy released by the new molecular combination must be greater than the energy absorbed in breaking the bonds of the constituent molecules. This allows an increment of energy to be set free to raise the temperature, and thus the kinetic energy, of the molecules which did not oxidize in the first place because of a lack of energy of activation.

Mechanism of Ignition in Gases

All known sources of ignition, flames—hot solids, spark discharges, arcs—have similar characteristics in that their ability to ignite depends upon temperature, time, and volume. Any ignition source, of a given volume at a given temperature, requires a fixed time in contact with the gas to initiate combustion. The same volume at a higher temperature requires less time; a smaller volume at a lower temperature requires more time; a greater volume will initiate combustion at a lower temperature in a reduced period of time.

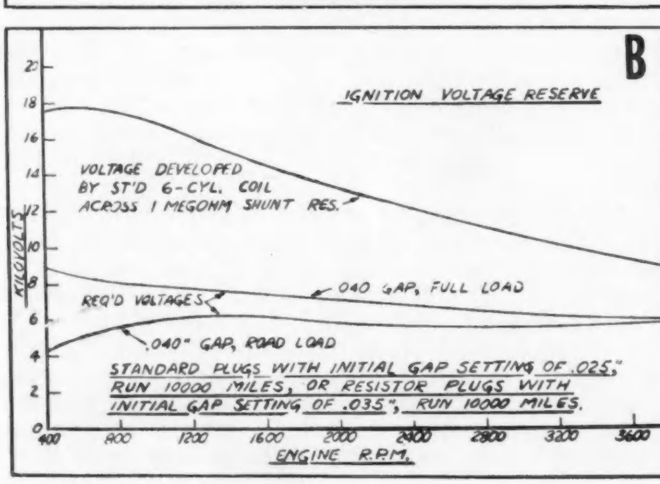
How Ignition Theory

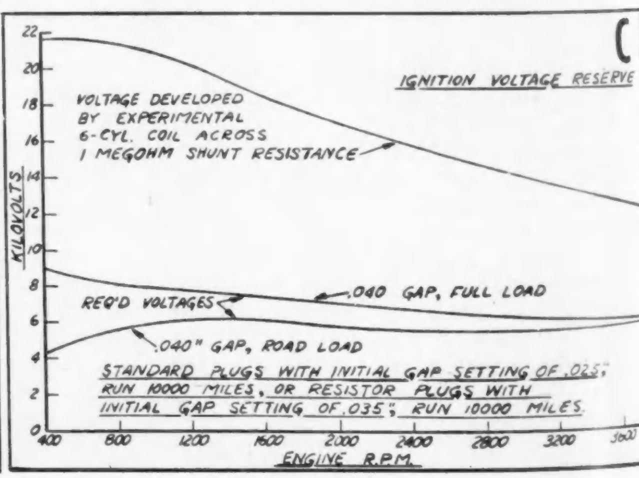


A. Improvement in open circuit voltage achieved in an experimental coil by changes in the magnetic circuit and in the use of copper

B. This is the excess voltage available from the standard coil over that required at road load and wide-open throttle, on resistor or nonresistor plugs, after 10,000 miles of operation. Now look at chart C

C. Note how much greater is the ignition voltage reserve available from the improved coil over that from the standard coil, under the same conditions





Therefore, any combination of the three variables can suffice for effective ignition. Since all three known sources of ignition have similar ignition characteristics, their ability to initiate combustion must be dependent upon an identical property, and the obvious property common to all these sources is "heat."

Thermal Theory of Ignition

Based on these simple facts, R. V. Wheeler has put forth the hypothesis that ignition depends upon the heating of a sufficient volume of the gas to a sufficient temperature. If we accept this hypothesis for the time being, it is apparent that we must examine the phenomena of thermal conductivity in gases to determine in what manner it will be best to heat this sufficient volume to a sufficient temperature.

Morgan has examined the various possibilities assuming the gas to be air, and has calculated the forms of the temperatures waves to be expected for the following modes of heat addition:

a. Instantaneous point source of heat.
b. Continuous point source of heat.
c. Instantaneous spherical surface source of heat.
d. Instantaneous volume source of heat.

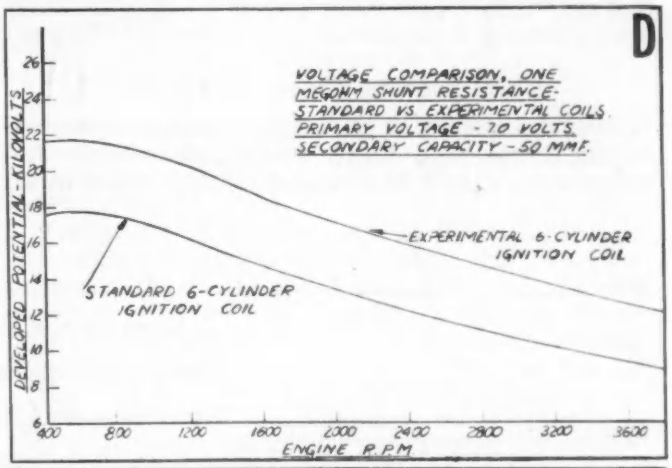
The wave form for each of the above is shown in Fig. 1, from which we can conclude that the greatest volume of gas will be raised to the ignition temperature by supplying the heat instantaneously at a spherical surface source. Conversely, it may be stated that a number of simultaneous sparks arranged closely together would, from the purely heat transfer point of view, be more effective than a single spark of the same length and heat content.

Taylor-Jones has shown mathematically that in a given medium of uniform conductivity, if a given quantity of heat is supplied in a finite interval of time, the maximum temperature at any neighboring point is lower than it would have been had the heat been supplied instantaneously. It may thus be deduced that so far as heat transfer is concerned, the energy required to effect ignition is reduced as the rate of energy dissipation is increased.

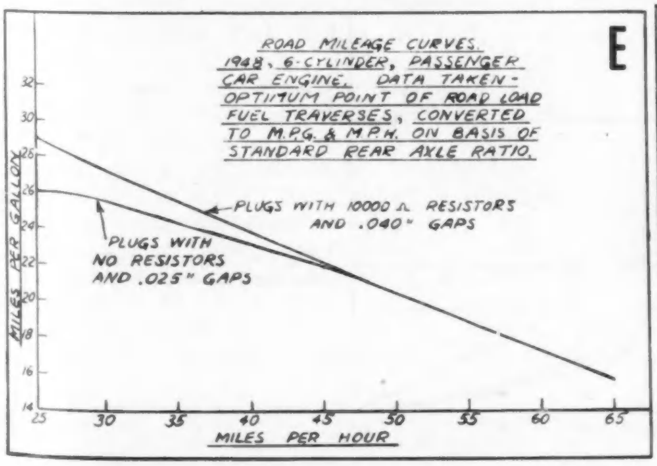
The thermal theory describing the physics of ignition does not explain the mechanism of ignition where the chemical reaction of the fuel is concerned. It does, however, indicate the most effective means of utilizing the energy available for ignition, and as such is a very useful concept. It is also clearly indicative that certain factors in spark plug design are of extreme importance in the

Yields Practical Results

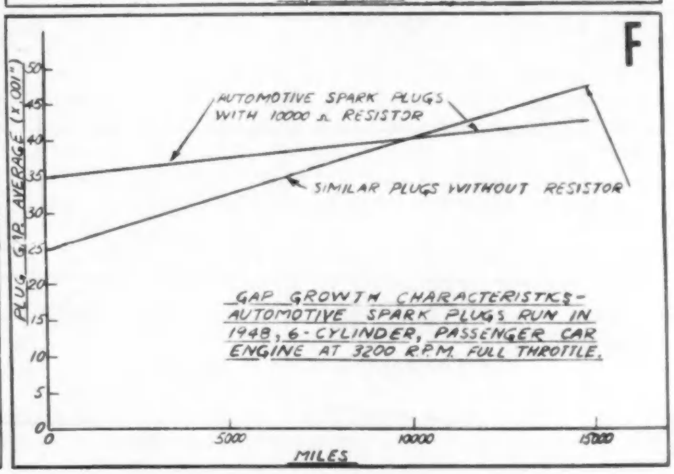
D. The experimental 6-cyl coil also shows an improvement in voltage across a 1 meg shunt over the standard coil



E. Use of resistor plugs with 0.040-in. gap settings can stretch gasoline mileage as compared to nonresistor plugs with 0.025-in. settings



F. Resistor plugs with initial gap settings of 0.035 in. exhibit slower gap erosion than nonresistor plugs with 0.025-in. initial gap settings



improvement of the effectiveness of the initiation of combustion.

It is now believed that the thermal theory is incomplete, involving as it does, an "ignition temperature," where it is most unlikely that the total energy in the spark is effective chemically only in its most depreciated form—heat. Particularly is this so when ionization and molecular activation, together with splitting, are known to take place considerably earlier than the energy is changed into heat.

Furthermore, the proponent of this theory, by his own experiments, concludes that at least in the case of the nonexplosive chemical conversion of explosive mixtures, combustion takes place only in the luminous portion of the discharge or in that part where ionization, molecular activation, and gaseous disassociation occur.

Ionization Theory of Ignition

Since the nature of chemical combination is believed to be electrical, many investigators have theorized that ignition in gases by means of a spark discharge is in some way associated with the ionization process, if not indeed its ultimate and logical conclusion. In 1910, J. J. Thomson was the first to suggest that electrically-charged particles might promote chemical reaction in gases, and Finch and Thomson have done much to further the theory.

But the fact remains that no investigator so far has succeeded in initiating or accelerating combustion in gases by means of ionization alone. It therefore appears that the most reasonable view at this time is to regard ionization as a supplementary rather than a fundamental mechanism of ignition.

Chain Reaction Theory of Ignition

With the advent of the chain reaction theory of chemical reaction, some investigators have attempted to explain the fundamental mechanism of ignition in gases by means of active ions, atoms, and molecules, which are regarded as chain carriers for the chain reaction. H. G. Landau has developed this theory mathematically, and conceives of the physical mechanism as follows:

In a gas ignited by an electric spark, a small spherical volume of the gas is heated instantaneously, and at the same time a quantity of active particles is created. It is of no importance whether these particles are ions, atoms, or molecules; nor is it important to state how such particles are created. It is merely sufficient to state that a heat-generating reaction takes place at a rate proportional to the concentration of active particles, and that this reaction varies in intensity as the active particles diffuse through the gas and increase at a rate proportional to their local concentration. Now the temperature at the center of the sphere tends to fall as heat is conducted away and rise as heat is generated. Thus, for the reaction to be self-sustaining, we must assume a reaction rate such that this temperature never decreases during the combustion process.

Landau then concludes, as the result of mathematical analysis, that ignition is possible only if the source raises some volume of the mixture to a high enough temperature for the chain branching reactions to supply this minimum quantity of heat.

At this point, the similarity of the chain reaction theory to the thermal theory is worthy of note. However, its importance is still largely a matter for debate. No less an authority than Morgan states that in his opinion the chain reaction theory has a question relevance to the mechanism of ignition from local sources. On the other hand, Jost is emphatic in his statement that activation of ions and molecules occurs before the spark energy depreciates to heat and is, therefore, of prime importance in the ignition process.

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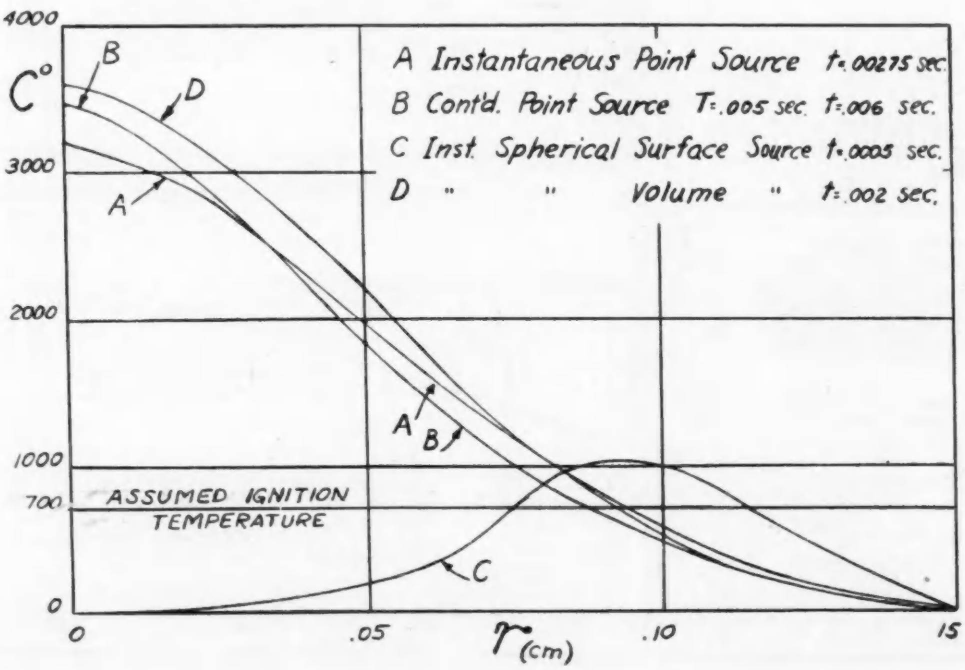


Fig. 1—Temperature wave forms for the four methods of heating air

In his complete paper, "Passenger Car Brake Performance—Limitations and Future Requirements," from which this article has been excerpted, Chase makes a comprehensive analysis of brake engineering problems. He is chairman of the SAE Brake Committee.

He discusses braking characteristics from the standpoint of available stopping ability, coefficient of friction between tire and road, and pedal pressure versus acceleration. Another item detailed is the geometry and mathematics of self-actuation—the factor that makes it possible to get sufficient braking power for passenger cars in the restricted space available.

Also part of the complete paper is a comparative analysis of the three brake types —one-piece shoe, duo-servo, and two-cylinder brakes.

VEHICLE BRAKE Viewed as Energy Converter

EXCERPTS FROM PAPER* BY

T. P. Chase

Research Laboratories Division
General Motors Corp.

BIG cause of changes in the frictional relationship between brake shoe and drum—producing changes in brake ability—is variations in the lining's coefficient of friction and changes in dimensional relationship of the shoe and drum. These primarily result from the heat developed during conversion of kinetic energy into heat energy.

Everyone knows that brakes get hot; engineers realize that kinetic energy varies as the square of the speed; but very few are aware of the heat equivalent of the energy possessed by a vehicle traveling at high speed.

Kinetic energy of a car in the smaller low-priced group, traveling at maximum speed, is about 800,000 ft-lb; the heat equivalent is 1050 Btu. For larger and faster cars the kinetic energy at maximum speed is over 1,500,000 ft-lb with a heat equivalent of 1925 Btu.

The metallurgist estimates that it takes 550 Btu to melt a pound of iron in the cupola. If the weight of a cubic inch of cast iron is taken as 0.26 lb, 1050 Btu of heat will melt a 1⅜-in. cube weighing 1.9 lb. Similarly, 1925 Btu will melt a 2⅜-in. cube weighing 3½ lb.

Another significant fact is that 75% of this heat is developed during the first half of the brake application. This, plus the fact that brakes also must overcome the force of gravity, is why extremely high temperatures are attained on winding mountain grades.

Fig. 1 is a record of simultaneous temperature readings taken at one minute intervals during 67 min of driving with comparatively mild brake service. Thermocouples were installed near the center of one front and one rear brake shoe and touched the shoe side of the cemented-on linings which had been worn thin by service. The other two couples were in holes, drilled part way through the drums, so that the thermocouples were about the same distance from the friction surface.

This record illustrates several interesting points. They are:

1. It took 15 to 20 min for the brakes to cool to the original temperatures from those reached at the end of the 5 to 6 sec required to stop.

2. The drums cooled to a lower temperature than the shoes near the end of the cooling cycle.

3. Temperatures reached in the drums are much higher than those attained by the shoes, due to the poor heat conductivity of lining material.

Drum temperatures observed during average driv-

*Paper "Passenger Car Brake Performance—Limitations and Future Requirements," was presented at SAE National Passenger Car and Production Meeting, Detroit, March 3, 1948.

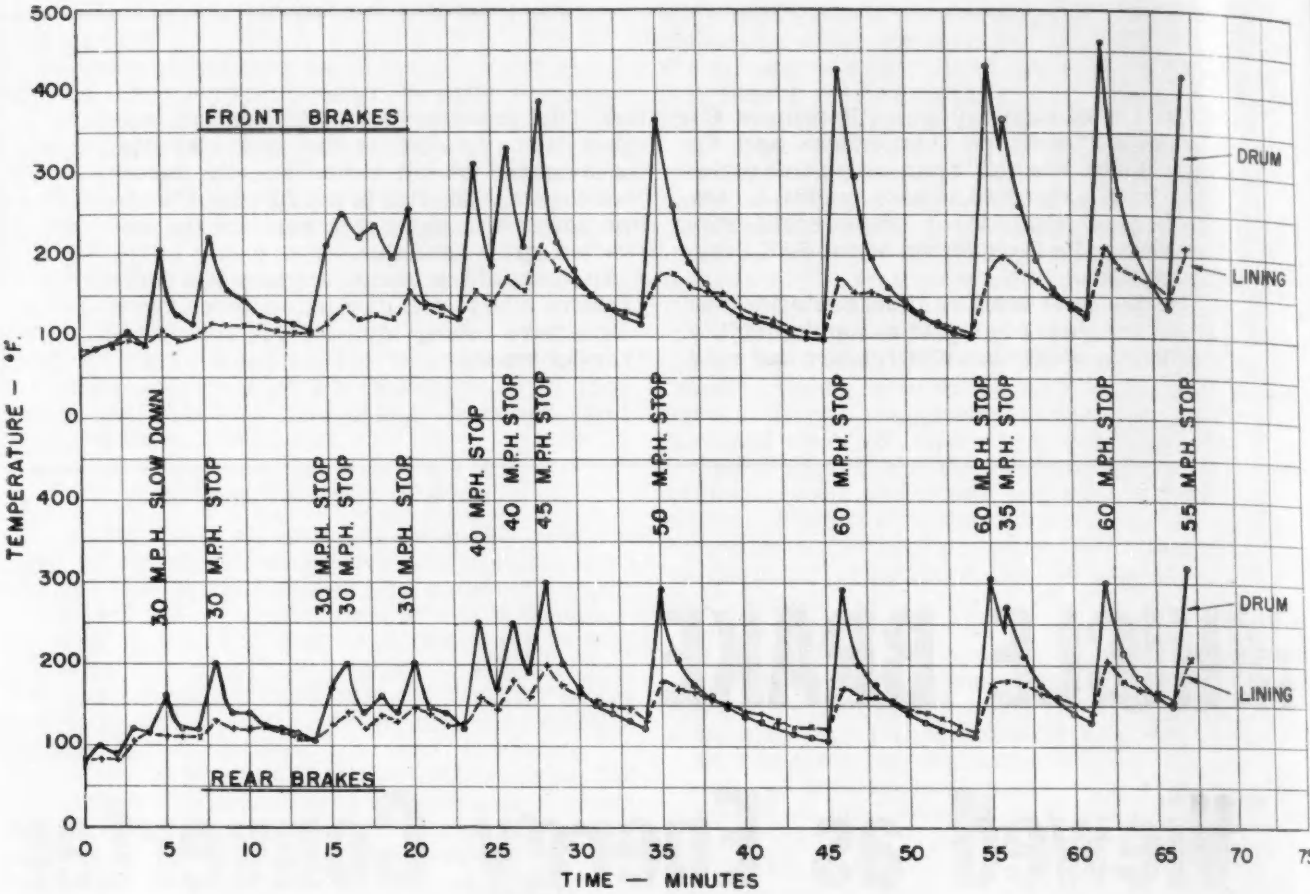


Fig. 1—These car brake drum and lining bond-line temperatures were recorded during a 67-min test run, including both city and country driving

ing conditions ranged from 200F to 400F, and there was no serious damage done to the lining or drums. However, when braking conditions imposed are more severe and the intervals between applications shorter, the cumulative effect of the prolonged cooling period becomes serious.

Drums expand and surface temperatures reach very high values during the brake application. The first result is that the coefficient of friction of most linings decreases to a very low value at elevated temperatures, which reduces torque exponentially. A further result not generally appreciated is that the shoes heat more slowly than the drum, so that the radius of the shoe is less than the radius of the drum. This causes an additional reduction of torque because of the reduced effective length of the shoe.

If severe braking continues any considerable length of time with brakes hot, the surface of the lining will be burned and will wear at a very rapid rate to the radius of the enlarged drum. When the brakes have cooled, the radius of the shoes will be larger than normal and the pressure will be higher than normal at the toe and heel. This makes self-actuation abnormally high until the linings have worn to the radius of the cool drum.

Any considerable change in the frictional relationship of the shoe and drum will be much greater for the self-actuating brake. Also, if high coefficient lining is used, to increase the percentage of actuation and thus get greater output, one must expect greater sensitivity, or less stable performance.

We've already noted that work and the equivalent heat developed varies as the square of the speed. Therefore, the increased driving speeds and frequency of brake application resulting from improved highways and increased traffic congestion is making the high-temperature limitation a continually more serious problem.

At the same time, the available space and cooling possibilities have been continually reduced by smaller disc wheels, wider rims, and larger section tires. The stylist also has done a very good job of developing the low chassis, wide bumpers, and the deep streamlined fenders that have effectively handicapped the cooling possibilities of the brakes.

All these considerations lead to the important conclusion that self-actuation—while essential to passenger car braking—should not be used more than is absolutely necessary.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

HYDRAULIC DRIVES

BASED ON PAPER* BY

Carl C. Lindblom
Chief Engineer
WHITE MOTOR CO.

INFINITELY variable hydraulic torque converters offer a logical approach to speed, economy and low maintenance—all of which are objectives of sound engineering.

These devices offer:

- Torque multiplication and provide smooth, flexible drive even during deceleration;
- Speed control through the accelerator;
- Better performance for a given power weight ratio, and
- Most efficient use of powerplant output.

They eliminate:

- Low speed lugging in the critical detonation range, and in turn improve spark timing making higher compression ratios possible, and
- Clutch frogging and gear clashing.

Shock loads are minimized, engine and drive train vibrations are isolated and subdued, vehicle life is extended, driver effort is decreased, and passenger comfort is increased by these devices.

In the final analysis, cost per passenger mile is reduced and the clash-type manual shift gear box appears to have served its purpose as far as motor coaches are concerned.

A disadvantage of the gear train is that torque multiplication is always equivalent to the meshed gear combination and the engine torque curve is reproduced proportionately. Unfortunately, the internal combustion engine torque and fuel economy curves drop off at low speeds when the demand for high torque is the greatest.

Thus, a transmission is needed incorporating the features of the hydraulic torque converter by providing torque multiplication with decreasing speeds to permit the engine to operate in its most efficient range.

Lysholm, applying his knowledge of steam turbine theory to the torque converter, effected a broadening of Foettinger's 1905 speed range at high efficiency. He cut out converter above a certain speed range and shifted directly into mechanical drive, and bypassed the converter operation in the high-speed, low-efficiency range.

Schneider contributed a new type of blading for high efficiency and made the simple single-stage converter economical for automotive use in combination with two or more operating speed ranges. This combined the advantages of the hydraulic torque converter and the hydraulic coupling into a self-contained unit by means of a free-wheeling reaction member which permits a hydraulic drive throughout all speed ranges.

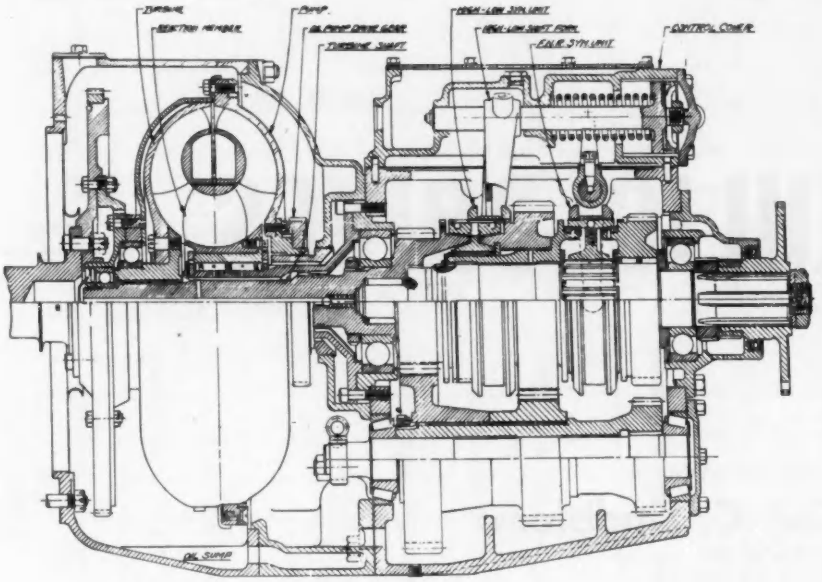
The motor coach industry has provided the real stimulus toward the development of hydraulic torque converter transmissions for successful automotive use. Prominent in the field today are the White Hydrotorque Drive and the Spicer converter.

The ~~former~~ latter is a multi-stage unit with a single centrifugal pump, two reaction member stages, and three turbine stages,—all close-coupled. The pump imparts kinetic energy to the converter fluid, and this energy is converted back into mechanical energy in the turbine staging.

This converter is designed to produce a relatively high initial torque increase that may approach the ratio of six to one. The clutch point, where torque input equals torque output, occurs at the ratio of speed of the turbine output shaft to speed of the engine. At, or near, the clutch point it shifts into direct mechanical drive from engine to propeller shaft to preserve high efficiency.

The White Hydrotorque combines the features of an hydraulic torque converter and an hydraulic

*Paper "Hydraulic Drives" was presented April 2, 1948, at the SAE Colorado Section; May 12 British Columbia Section, and May 19 Southern California Section.



• White Hydrotorque with automatic controls to determine occurrence of gearshifts, based on actual road load requirements, or upon action of driver

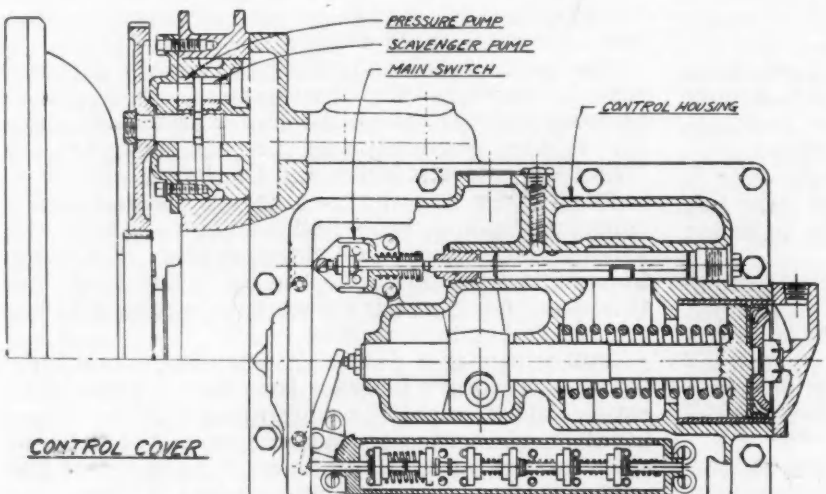
coupling with a two-speed gear box which extends the converter range of torque multiplication and provides exceptional accelerations in the low-speed range.

The hydraulic unit of the converter contains the pump, the turbine, and the reaction member. The pump discharges directly into the turbine, and the turbine discharges directly back into the pump suction after the oil flow direction has been changed by the reaction member. This close-coupled arrangement is responsible for the over-all efficiency of the unit because considerable loss has been eliminated. The reaction member is the device within the converter that makes a torque increase possible.

In one direction of rotation it is anchored firmly to the transmission case, which is fastened to the frame of the vehicle. It is free to rotate in the other direction.

This member absorbs the difference between the torque delivered by the engine and that available for delivery to the main propeller shaft of the vehicle. It is essentially a fulcrum point. If there were no reaction member, or if the reaction member were free to rotate in both directions, it would be similar to the familiar passenger car fluid couplings, and thus could not increase torque.

A torque converter, as distinguished from an hydraulic coupling or fluid flywheel, is that it *does* provide torque multiplication and it *does* provide a relatively high efficiency of conversion of energy from the engine to the propeller shaft when the vehicle is accelerating from a standstill to a moder-



• Showing how shift to high by air pressure is accomplished: Shift fork engages the high and low shift collar. This is supplied with spring in case of pressure drop or battery failure

ate speed. Hydraulic coupling efficiency is relatively low in this range.

However, when the speed ratio between the turbine and the engine is increased, or when the vehicle has been accelerated to a moderate speed on level ground, the torque converter falls off in efficiency. Then it is desirable to use the characteristic of the hydraulic coupling.

These functions are carried out in the White Hydrotorque by the one-way clutch reaction member. When the vehicle is being accelerated from a low speed or standstill, the angle of attack of the oil issuing from the turbine into the reaction member is such as to cause the reaction member to tend to rotate in a direction counter to that of the turbine. The one-way clutch resists this tendency, and locks the reaction member to the transmission case.

As the vehicle is accelerated to a moderate speed, the angle of the oil from the turbine automatically changes until engine torque equals turbine torque. Then the force on the reaction member shifts over to the opposite side of the reaction member blades, causing the reaction member to rotate in the same direction as the turbine. Permitted by the one-way clutch, the converter becomes an hydraulic coupling.

The hydraulic unit is fully automatic, efficient, simple, and quiet.

A two speed gear box provides excellent accelerations from low speeds and good downhill engine braking, as well as uphill and emergency climbing or pulling ability. It also has a reversing mechanism.

The automatically controlled shift from low to high gear is accomplished by a piston actuated by compressed air. The return from high to low gear is accomplished by a spring. Selection of forward, neutral, or reverse is manual.

An electro-pneumatic control system coordinates the separate functions of the hydraulic unit and mechanical gear box.

In normal drive-away from standstill the driver simply presses the accelerator pedal.

In passing another vehicle while still in low gear the driver may want to continue in low until he has passed. He simply flicks an over-rule switch, and no upshift can occur.

Or he may elect to upshift in advance of the auto-control action. In existing cases, the automatic shift would occur at about 22 mph. In this instance he accelerates to somewhat over seven mph, and momentarily releases his foot from the accelerator. The shift automatically takes place, and he again accelerates.

At the crest of a hill while in high gear and prior to descent, the driver brakes the vehicle and momentarily depresses the accelerator. A downshift occurs, and the vehicle remains in low to the bottom of the hill. If the driver desires an upshift he again depresses the accelerator.

In slowing to a stop on slippery pavement the driver does not have to do anything. The transmission remains in high as the vehicle stops. The downshift occurs automatically when he depresses the accelerator for the next start.

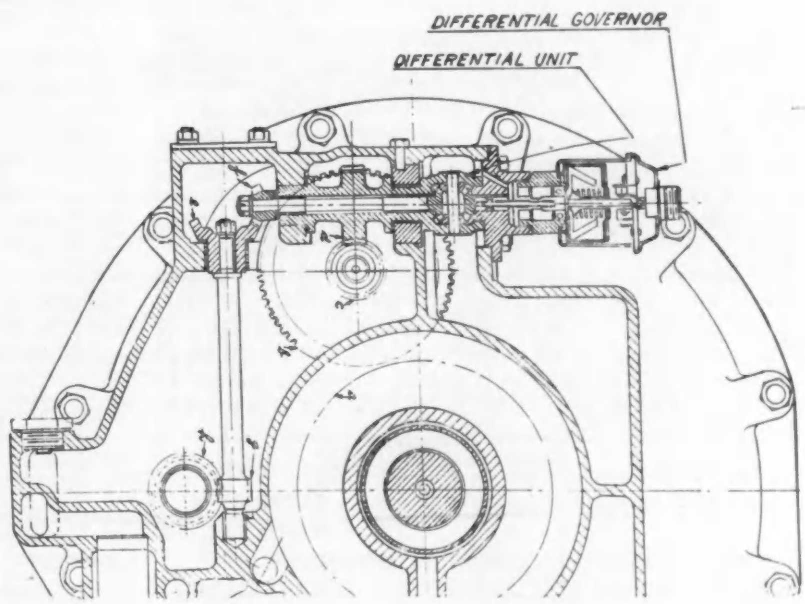
When the vehicle starts up a steep grade in high gear, the controls sense the need for shifts and the transmission performs them automatically.

These simple controls free the hands for steering, and eyes are not distracted by having to hunt for pedals and levers. Although the transmission is automatic, driver is in control.

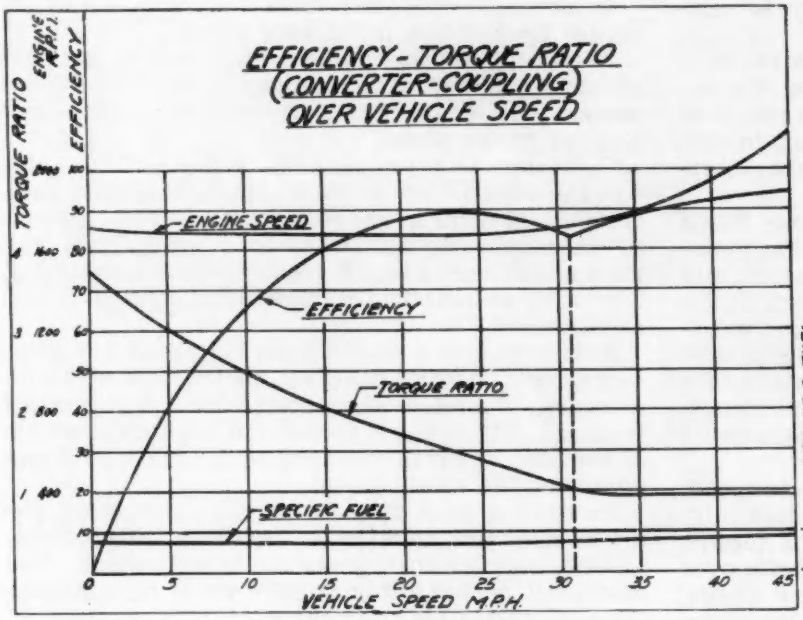
Shift from high to low and *vice versa* is by a piston contained in the transmission control cover. This is mounted on top of the transmission case.

The heart of the Hydrotorque Drive control is the differential unit and the differential governor. The differential cage is gear-driven in proportion to engine speed.

An upshift starts when the speed difference reaches a minimum, and a downshift begins when the speed difference attains a maximum. Control becomes independent of the vehicle speed because



• Differential governor and unit in which lower pinion is geardriven in proportion to turbine speed. Thus upper pinion rotates at speed proportional to speed-difference between engine and turbine. Two series of weights actuate switches, which give positive action without hunting. Governor gives signal initiating switch



the upshift may be called for at full or part throttle at entirely different vehicle speeds.

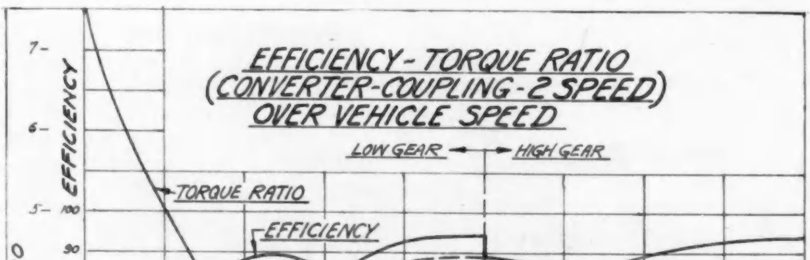
A low-speed governor returns the transmission to low gear below a certain vehicle speed. This is mounted in the rear of the transmission, and is driven from the transmission output shaft at vehicle speed.

Both upshift and downshift cycles are essentially the same as on the manually operated transmission, except that no clutch is actuated.

When the differential governor gives the signal for the upshift, engine speed is decreased by automatic closing of the carburetor, which causes a torque reversal in the driving connection of the low gear. Air is admitted under pressure to the shift piston moving the shift collar from low toward high. After synchronization is established, the shift is completed and the carburetor butterfly opens automatically, permitting the engine to accelerate in accordance with the accelerator position.

The downshift cycle similarly proceeds as a downshift of a manually operated transmission, including double-clutching. When the differential governor gives the down signal, the carburetor butterfly closes momentarily, causing a torque reversal in the driving connection of the high gear.

Concurrently, the air pressure to the shift piston is cut off, causing the spring to move the shift piston toward low gear. After the synchromesh collar



is disengaged from the main drive gear, the carburetor opens automatically so as to increase the engine speed, thereby relieving the synchromesh unit of as much work as possible.

When synchronization is established, the ignition is interrupted and the final engagement to low is made while the engine torque is interrupted. On completion of the engagement to low, the ignition is restored, and the engine speeds up with the prevailing accelerator position.

A downshift can also be initiated through the low-speed governor when the vehicle is below a certain minimum speed. This downshift cycle is essentially similar.

When the vehicle is descending a hill and driving the engine a switch in the low speed governor holds the transmission in low gear. Power is transmitted to the turbine wheel of the converter and from there to the pump, driving the engine. Because the vanes of the wheels have not been designed for power transmission in this direction, this low efficiency cannot establish minimum speed required for an upshift, and therefore the transmission will stay in low gear irrespective of speed of vehicle.

To get out of low, the driver steps on the accelerator. This speeds the engine up to and beyond the turbine speed, creating the minimum speed difference, and causing an upshift. Furthermore, the engine speed will always be lower than with a manually operating transmission, contributing to extended engine life.

Loss of power occurring in the converter during this phase serves as an increased braking effect.

The Hydrotorque is operated on the dry-sump principle with a duel rotary pump. One section of this device is a scavenger pump which picks up oil from the converter housing and passes it through an oil cooler before depositing it in the reservoir tank.

The other half of the dual pump picks up oil from the reservoir tank and delivers it under pressure to keep the converter wheels full and provide lubrication for the moving parts of the converter and gear box. Oil is basically an engine oil with additives to prevent excessive oxidation and foaming.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

IGNITION THEORY

Continued from P. 50

Practical application of the fundamentals of ignition in our present work stems from the rather modest combination of four well-known, but perhaps not too appreciated facts.

The first fact is that by increasing gap settings on spark plugs a leaner mixture can be burned. You will immediately ask why. Our answer is first, because the surface-to-volume ratio of the initiating sphere of burning fuel is less favorable to heat loss during the critical time when combustion is being initiated. Less activating energy is therefore required to initiate combustion. Secondly, the initiating sphere once kindled, being larger in size with a larger gap setting, progresses more rapidly through the unburned mixture because of the greater surface it presents to the unburned mixture.

The second fact is that by incorporating a 10,000-ohm resistor in the spark plug, a very substantial reduction in electrode erosion can be obtained . . . so much so that with resistor plugs set initially at 0.035 as against nonresistor plugs set initially at 0.025 after 10,000 miles both types of plugs will have eroded to 0.040. And the difference in voltage requirements will, if anything, favor the resistor type plugs, because of the relative sharp edges which will still be found on the resistor plug electrodes.

The third fact is that resistor plugs do not have a practical detrimental effect upon starting. This is so simply because of the reduced gap erosion, and the fact that generally after use, their required voltage is actually less than that of nonresistor plugs.

The fourth fact is that by improvements in the magnetic circuit of the average automotive coil, increased voltage can be obtained without increasing primary current. Also some very high frequency secondary oscillations can be obtained in the portion of the spark discharge immediately following ignition. It is our contention, that these oscillations, well up in the megacycle range, can and do, under part throttle conditions, contribute to the flame propagation process. It's done either by creating nascent oxygen, or mechanically by accelerating expansion of the initiating sphere of burning gases—the adiabatic wave of compression emanating from the spark itself.

(Practical results of these themes are illustrated in this article.)

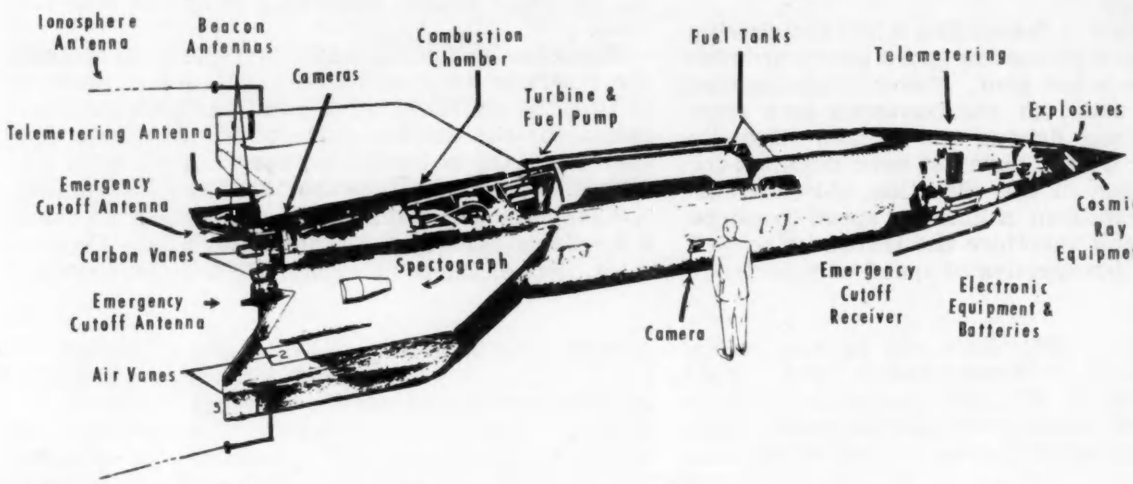
(Complete paper on which this article is based is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

BASED ON PAPER* BY

Lt.-Col. W. L. Clay

Ordnance Department
U. S. Army

V-2 ROCKET



• V-2 equipped for study of earth's upper atmosphere

INDUSTRIAL research experts and universities are exploring astrophysics, cosmic rays, ionization, atmospheric, and biological phenomena of the upper atmosphere while the Army and Navy are advancing knowledge of offensive and defensive rocket warfare at the White Sands Proving Ground, N. Mex.

The present program with the V-2 rocket began in March, 1946, and will close this year. This will be followed by a series of launchings of the Martin Aerobee, and as soon as it is finished, with Martin Neptunes. That part of the test program is expected to run into 1951.

V-2 rockets used in this work are copied as closely as possible from the German prototype as to weight, weight distribution, and overall dimensions. But the rocket is filled with elaborate instrumentation to record phenomena that has been until now, far beyond the range of man's knowledge.

First modification has been to increase height reached by altering the German V-2's trajectory. A new nose tip was designed to house experimental and test equipment. The nose section was also changed to take cosmic ray counters, solar spectrograph, and the body was sealed at one atmosphere at ground level and housed electronic equipment, batteries, and ground controls used prior to launching.

A radio system which permitted an operator on the ground to cut off the fuel supply was an adaptation of the five-channel FM control system developed during the war. It is so designed that three channels must be closed before cutoff is accomplished, minimizing unintentional cutoff of fuel due to electronic disturbances.

Complete details of the German V-2 rocket have never been assembled, and most of our knowledge of the weapon came from examination of damaged parts, interviews with captured German technicians, and manuals, but only four launchings of the first 25 rockets were failures.

On one of the launchings photographs were taken of solar spectra, the first ever obtained from above the ozone of the upper atmosphere. Solar spectra in the ultraviolet below 3400 Angstrom units were photographed up to the altitude of 88 km (54.68 miles), and showed that with increased altitude they progressively extend into the ultraviolet. Comparing these pictures with the spectrum of a calibrated carbon arc to extend the curve of average radiant energy as a function of wavelength, the ultraviolet intensities are much less than had been predicted, this experiment showed.

The first data on cosmic rays obtained above the atmosphere where the primary radiation could be studied directly were obtained with other rockets with specially equipped laboratory counting devices which telemetered the information back to the launching station.

The first four rockets assigned to this investigation disclosed that the greater portion of primary radiation of the cosmic ray consists of particles

* Paper "Results of V-2 Rocket Tests" was presented at the SAE Detroit Section, Oct. 20, 1947.

TESTS

hard enough to penetrate at least 12 to 15 cm of lead, and about one out of every five such particles will produce a shower in 12 cm of lead.

This work also disclosed that a non-primary soft component exists above the atmosphere, equal to about one-fourth the total number of particles present.

Telemetering devices to record findings aloft are important because recovery of an undamaged record after the impact of landing is seldom possible. Parachutes are used, but the landing impact is about 2400 mph unless the speed is decelerated.

The equipment used to telemeter the information to the ground station includes a 23 channel sequential pulse time modulated transmitter, with a peak output of 1200 w at 1000 mg. It is mounted in a pressurized case, and weighs about 150 lb.

Its chief job is to automatically radio back to the receiving station on the ground temperatures, air pressures, characteristic of primary cosmic radiation, and properties of the ionosphere.

It also transmits the rocket's velocity, acceleration, skin temperature, and the motion of the control fins.

When data wanted cannot be reported electronically, the warhead or flying laboratory is made detachable, and exploded off at the proper time by a radio link or a timing mechanism in the rocket. The aerodynamic characteristics of the rocket are spoiled, but with the warhead now in the tail section, has a reasonably good chance of recovering if it floats to the ground slowly.

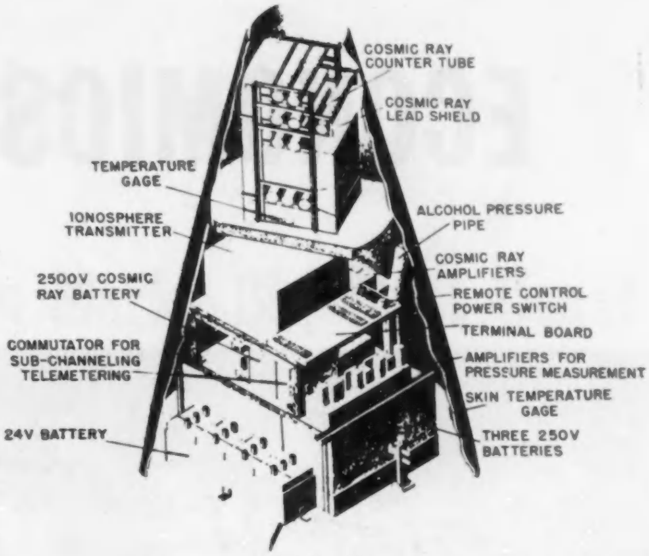
Another method is to eject the instruments to which has been attached a large nylon parachute. Three smoke flares aided ground observers to locate the instruments.

Trajectory, flight control, and other considerations are of particular interest to the Ordnance Department, Signal Corps, and Navy Department.

Calculations of the trajectory wanted are made before the launching, and the missiles are actually tracked in flight to see if they perform as required.

The three methods used in tracing the course of the V-2 are:

- Optical, with 13 observation stations each equipped with high speed moving picture cameras and other instruments;
- Radio transmission on one frequency to the rocket and a retransmission to the ground station at twice that frequency. In this, the Doppler system, the outgoing and the received signal beat together at the ground station, and this beat is the function of velocity of the missile. This system is also used in triangulation:



• Arrangement of recording instruments in V-2 warhead

- Radar, which automatically traces the line of flight and the visual record is photographed.

From all the V-2 parts collected by Army and Navy technical intelligence personnel overseas and shipped home, only two complete rockets could be assembled. Despite interrogation of German personnel and examination of German specifications and drawings, complete technical data on all the components is unavailable.

Parts were carefully examined and analyzed for chemical composition of materials, dimensions, and workmanship. In one case more than 40 manufacturers were contacted before one was found which could produce a part with metric dimensions.

One failure was caused because a graphite vane disintegrated soon after launching. It headed off east instead of north, but the fuel was cut off from the ground control station.

Another exploded at 28,000 ft 27 sec following takeoff. Visual inspection of the wreck indicated that an outboard bearing overheated and this caused the fuel tanks to let go.

Steering failures accounted for several unsuccessful launchings. German technicians, however, explained that they had faced similar types of trouble during the last phases of the war.

One of the two gyroscopes which control the V-2 prevents the roll and provides control in the azimuth. The other, a pitch control unit, to control trajectory during the burning period. Their axes maintained the direction in which the rocket was aligned during the burning period, and in flight maintained this direction, one along the rocket axis, and the other horizontal and perpendicular to the direction of the target.

Deviations were detected by potentiometers which furnished control voltages to electrical-hydraulic servos.

(Complete paper on which this article is based is available from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

ECONOMICS Pace Design,

Panel of Experts who handled the "Stump the Experts" questions (left to right): E. S. Ross, Peterbilt Motors Co.; W. J. Cumming, White Motor Co.; E. W. Dryer and D. F. Lemaux, General Motors Corp.; F. E. Sandberg, Ford Motor Co.; Fred Smalley and Fred B. Lautzenhiser, International Harvester Co.; R. C. Norrie, Kenworth Motor Truck Corp. and R. Wayne Goodale, Standard Oil Co. of Calif. Murray Aitken, Kenworth Motor Truck Corp. was chairman of the panel

ECONOMIC considerations are pacing automotive engineering and fleet operating practices the SAE National West Coast Meeting, Aug. 18 to 20, clearly disclosed.

From the broad discussion of the western states' future economy by Governor Herbert B. Maw, Utah, to design details of brakes, electrical equipment, diesel fuels, high compression engines, vehicle maintenance, and airline passengers' comfort, the meeting at the St. Francis Hotel in San Francisco kept engineers reminded that the basis of sound engineering is sound economics.

The 11 western states are working closely together, Governor Maw said, to develop industries to support large payrolls. Rich in high grade iron ores, aluminum, magnesium, copper, and other minerals, the west is moving into sound industrialism with the increase of peacetime processing and manufacturing plants.

"The economy of the west is dependent upon the automotive industry primarily," he told the Fruehauf luncheon Thursday.

T. S. Peterson, president of Standard Oil Co. (Calif.), told the Ethyl luncheon next day that California now is supplying its own petroleum needs with crude production of 951,000 bbl a day. But with few new resources found during the past 25 years except for the Salinas Valley fields, he said, importations must be resorted to in the future as the population of the western states increases.

"This is similar to the outlook for the whole United States," he said. "In general, the prospects for petroleum products demands is going to exceed the availability of domestic crude oil."

"Meetings such as these let us see what our teammates are doing, give us an insight to their problems, and keep us all headed in the right direction in our common business of transportation by power," F. Glen Shoemaker, consulting engineer of Detroit Diesel Engine Division, General Motors Corp., told the banquet audience of nearly 500.

After reviewing the progress made in recent years by the engine industry, he concluded that the progressive increases of engine efficiency, reduction of weight to increase payload, and continued work on

• Photos courtesy of Elton B. Fox
—Field Editor, SAE Northern California Section

Meeting Is Told

Realism Marks Big West Coast Event; Expert Panel Is Feature

design refinements indicate that engine builders are headed in the right direction.

A feature of unusual interest was the "Stump-the-Experts" session Wednesday evening, presided over by Murray Aitken, chairman of the SAE Northwest Section.

Consensus of several engineers who discussed exhaust noises was that California state laws were becoming more strict about such noise, and that more rigid rules can be expected in 1949. Fan, tire, and gear shift noises are actually greater in many cases than exhaust noises, it was pointed out.

Whenever West Coast operators get together with vehicle designers, brakes become a prime topic. Much of the "Stump-the-Experts" panel was devoted to this subject because of the hard demands put on braking equipment in Pacific states operations.

Clearance between drum and rim should be $3/8$ to $1/2$ in. to reduce tire heating, and a sheet metal heat dam between the drum and tire has been developed to alleviate these troubles, it was disclosed. Although the weight penalty is rather too severe for most fleet operators, the eddy current type of electrical auxiliary brake and hydrostarter add life to the drum and decreases maintenance costs.

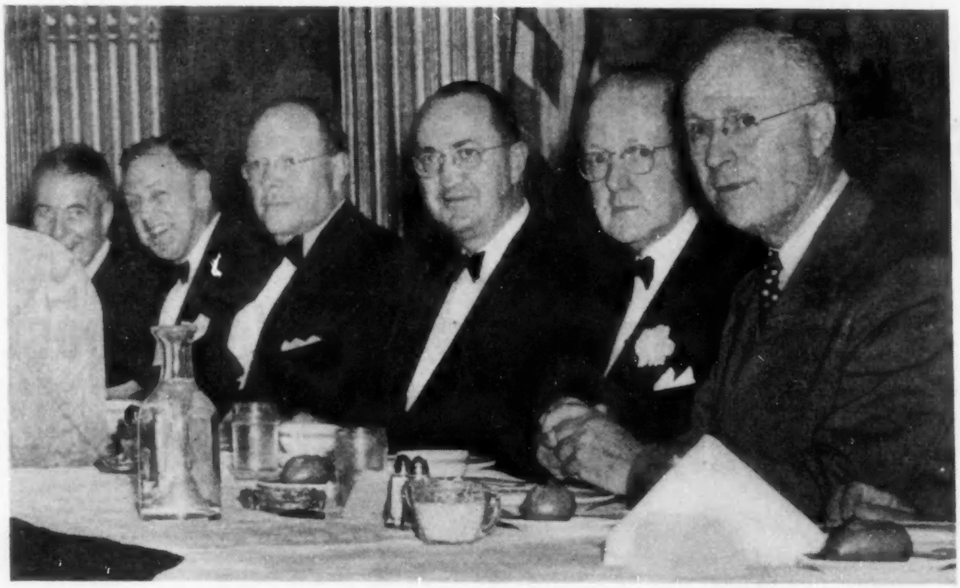
Heavy duty automatic transmissions can be expected in trucks and buses, although at present the largest is rated at about 150 hp, another expert predicted.

Simplification Cited

The discussion dwelt at some length on mechanic training and proper driver selection to reduce operating costs. A representative of Ford Motor Co. disclosed that his company is trying to simplify body replacements by making as many parts interchangeable as possible between different truck models.

How the diesel engine is rapidly taking its part as an important tool in our national economics was explained by F. Glen Shoemaker, Detroit Diesel En-

Mayor Elmer E. Robinson of San Francisco with SAE President R. J. S. Pigott, who responded to his honor's welcome to the SAE National West Coast Meeting in that city, Aug. 18 to 20



Part of the banquet speakers table (left to right): John A. C. Warner, SAE secretary and general manager; SAE President Pigott; Toastmaster J. Leonard Love from Salt Lake City; R. Wayne Goodale, general chairman of the meeting; F. Glen Shoemaker, principal speaker, and SAE Past-President C. E. Frudden

gine Division of General Motors Corp., principal speaker at the dinner which closed the meeting.

The meeting was sponsored by the SAE Diesel Engine, Fuels & Lubricants, Transportation & Maintenance, and Truck & Bus Activities, and by the eight West Coast Sections and Groups of the Society under the general chairmanship of R. Wayne Goodale, who is also chairman of the Northern California Section.

Other West Coast SAE Section and Group chairmen are Earl B. Richardson, Oregon; Murray Aitken, Northwest; G. A. Jackman, Spokane-Intermountain; L. D. Bonham, Southern California; J. H. Famme, San Diego; C. E. Smith, Salt Lake, and H. D. McDonald, British Columbia.

Hard-headed engineering on a wide automotive front was described by the 13 speakers who were invited to disclose what is new.

Brake Design Progressing

Today's automotive air brakes, one speaker pointed out, show marked improvements in faster application and release time as compared with pre-war equipment. Engineering research and development in this field, he said, is broader and of greater magnitude than anything that has been undertaken in the past, he said, predicting improvements in major units of the system for tomorrow.

Comparing application and release time in seconds for 1925, prewar, and postwar brakes he graphically demonstrated that progress toward greater safety is being made rapidly.

Brake valve capacity has been increased four times, treadle travel has been reduced, air brake systems have been improved, component installation has been simplified and their service life has been increased, and weights and sizes of units have been reduced by a program of constant engineering work.

But, he warned operators, careful maintenance of each component of an air brake system is essential to achieve the highest operating economy and the greatest degree of safety.

Automotive electrical engineering has made important strides during the past decade, and the advent of the a-c generator and electronic systems indicates the quest for higher efficiency is intensive, another speaker said.

The new dry charge d-c battery is easier to transport, delivers from 75 to 80% normal rated capacity as soon as it is filled with electrolyte without boosting or cycling, he reported.

Leakproof bond between case and covers under all operating conditions and temperatures is now a fact due to new sealing compounds.

Starting motors have become more durable and troublefree. Welded commutators reduce resistance between bars and conductors to a minimum, field coils and armature windings have better impregnation, and new alloys for switch contacts reduce voltage drop, burning, and sticking.

Filling condensers with oil improves service life, and oil filled coils provide long needed hermetic sealing. Distributors sealed against dust extend contact point life, and tend to reduce rubbing block wear.

The 160 amp 12 v are helping to supply increased electrical output for buses, and larger capacities are in the offing, but trained maintenance personnel is essential, the audience was warned.

Performance of hydraulic torque converters, unlike gear transmissions, can be predicted accurately. This fact leads many engineers to predict wide use of this equipment in trucks and buses. Design hints, disclosed by use of automatic transmissions in passenger cars, will be helpful in engineering heavy duty transmissions, another speaker pointed out.

Smoothness of drive with the torque converter was strikingly shown by charts, and the speaker pointed out that the accelerometer measures the driver's skill with the clutch and gear lever rather than serving as a check on the vehicle itself.

Although the hydraulic torque converter is simple in principle, its design and calculation is exceedingly complex. This, one author pointed out, is due

chiefly to the recirculation of the fluid.

Progress report on General Motors' long range fundamental research and development program on high compression engines to increase fuel economy was another highlight of the meeting.

Because internal combustion engines are by far the largest consumers of petroleum products, three GM research engineers wrote, even small gains in engine efficiency can mean much to our domestic economy.

They attribute about a half of the efficiency gains during the past 18 years to increases in octane numbers by petroleum refiners, and the remainder to refinements in engineering design based on studies of air-fuel ratios, spark advance, vacuum control of distributors, improved transmissions, and other mechanical improvements.

Engines Run Smoothly

Experimental work done to date demonstrates that high compression engines can be built to run smoothly, and large gains in fuel economy can be achieved—provided the required fuel can be made available to motorists.

Increasing the octane number of fuels to take advantage of the higher compression engines is admittedly an expensive refinery project, and the problem of wide distribution of such gasoline is one that will involve large cost and will take time.

Dual fuel systems, and injection of methyl alcohol, water, and tetraethyl lead were reviewed, but the authors pointed out that public acceptance of these devices is undetermined. GM has built several 8-1 compression engines which show as much as 25% gain in fuel economy with gasolines sold commercially since World War II.

The preventive maintenance program of one of the nation's largest highway freight fleets is based entirely on mileage schedules, and careful re-examination of the predetermined inspection periods has shown that these can be extended.

Essential factor in the plan, it was reported, is care in making and keeping records on each truck, tractor, and trailer. This program has prevented continued mistakes in costly overservicing and more costly and highly dangerous underservicing.

An interesting phase of the plan has been the disclosure, statistically, of these conclusions:

- Main shaft pilot bearings are the weakest part of all transmissions,
- The first gear has only about one half of the life of the others,
- Clutch splines on main drive gears wear far sooner than the gear teeth, and
- Tapered roller bearings would probably increase life of gear boxes.

Lag in application and release of air brakes, despite marked improvements reported by an earlier speaker, remains the most serious problem of West Coast vehicle operators.

Intensive laboratory and road test work on multipurpose gear lubricants, reported by another engineer, promise better predictions of service performance.

Extensive work done with SAE, Timken, Almen, a Falax testing machine, and four-square rear axle dynamometer setups was described. These new gear lubricants, now commercially available, are the best answer for hard service requirements, the testing program showed.

Cylinder and ring wear in diesel engines running on high sulfur fuels can be controlled by careful selection of cylinder and ring materials, an engine research expert reported.

Sulfur trioxide attacks the cylinder walls in the presence of moisture and combustion gases. In many operations high intake of abrasive dust spells early doom of working parts.

The constant increase of engine output per unit of displacement makes control of engine wear more difficult, but the speaker said that clues pointing to metallurgical solution will go far in reducing operating costs of diesel powerplants.

Vapor phase cooling of diesel engines, a system in which steam from coolant water is condensed and solid particles are settled out, has proved a money saver in many operations.

The speaker reported that oil refining companies have reduced inspection to only once a month. Lubricating oil is checked by sampling, valve tappets are adjusted, and other equipment is checked and parts replaced if needed.

Most important is constant diagnosis of the engine's internal condition by sampling the lubricating

Under the general chairmanship of **R. Wayne Goodale**, the following served as chairmen of the eight technical sessions of the SAE National West Coast Meeting: **Lester W. McLennan, Earl B. Richardson, George A. Jackman, L. D. Bonham, J. H. Framme, Gerald E. Chess,** and **C. E. Smith.** This report is partly based on discussions and 12 papers . . . "Recent Developments in Engines and Fuels for Higher Efficiency" by **J. M. Campbell, D. F. Caris,** and **L. L. Withrow,** Research Laboratories Division, General Motors Corp.; "Engine Bearing Failures" by **John Stokely,** California Research Corp.; "Air Brakes—Design and Performance, Past, Present, and Future" by **Stephen Johnson, Jr.,** Bendix Westinghouse Automotive Air Brake Co.; "Heavy Duty Electrical Brakes" by **William H. Foland,** Delco-Remy Division, GMC; "Diesel Engines of a High Speed, Heavy Duty Type for Automotive Service" by **O. D. Treiber,** Hercules Motor Corp.; "Marine and Industrial Type Diesel Engines" by **Hans Bohuslav,** Engineering Controls, Inc.; "Hydraulic Torque Converter Performance" by **A. H. Deimel,** Spicer Mfg. Division, Dana Corp.; "Heavy Duty Brakes—What's New" by **Ralph K. Super,** Timken-Detroit Axle Co.; "Sleeperette—The Answer to Passenger Comfort for Long Range Operation" by **Robert R. Houston** and **John M. Parker,** Pan American World Airways System; "Some Further Work on High Sulfur Diesel Fuels" by **Dr. L. A. Blanc,** Caterpillar Tractor Co.; "Performance Characteristics of Automotive Gear Lubricants" by **W. B. Bassett,** Lubrizol Corp., and "Production Line Methods of Service and Repair of Heavy Duty Highway Trucks" by **E. B. Ogden,** Consolidated Freightways, Inc. All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

oil regularly. In his experience changes in lubricating oil and cooling water conditions are more reliable indicators of an engine's condition than fuel consumption, exhaust gas temperatures, or smoke.

Between these periodic inspections makeup oil is added automatically, water is maintained at the proper level automatically, and engines are stopped automatically in case something goes wrong with these devices.

A pintle type, self oiling injection nozzle and a spherical auxiliary combustion chamber at the side of and at the top of each cylinder increases the diesel engine's efficiency, another engineer announced.

High speed of air revolution in this auxiliary chamber brings air density up to 500 psi. This tends to confine the fuel droplets toward the center of the combustion chamber and prevents them from hitting the hot cylinder walls.

Besides increasing efficiency, excessive exhaust smoke and unpleasant exhaust odors are eliminated.

Admitting a wide field for improving passenger comfort in airlines, two airline engineers described the Sleeperette seat can be turned quickly into a lounge or bed. In the upright chair position the device has an adjustable footrest, and folding table which can be inclined for reading, writing, using a typewriter, eating, or playing cards. This becomes a leg-rest in the semi-reclined position, and a part of the bed when prone.

Twenty-two airplanes were fitted with this type of seat for the Pan American World Airways System's Pacific-Alaska Division. Because of speed required in making the change a special shop was equipped in one of the hangars and maintenance men built almost all of the equipment and installed it.

About 86% of passengers asked expressed enthusiastic approval of the innovation. A simple arrangement of curtains to afford privacy was endorsed by 94% of the passengers.

EXPERIENCE WITH H-BAND SPECS

Continued from page 19

for individual elements, the summation of all the hardening elements in the steel must be more closely controlled in order to produce a hardenability within the H band. This is illustrated by Fig. 1.

This shows the range of hardenability for 8640 steel when purchased, in three different ways:

1. On the basis of standard specifications for chemical analysis. This is the widest range of hardenability.
2. When purchased under a specification for the minimum hardenability of the 8640-H steel, but the maximum limits on chemical analysis. This gives a little higher minimum hardenability, but the maximum remains as high as when chemical analysis only is specified.
3. The 8640-H specification restricts both the maximum and minimum hardenability limits.

What Replies Mean

On the whole, the answers to the questionnaire indicate that considerable improvement has been made in the elimination of the small percentage of heats, which are too low in hardenability to respond satisfactorily to production heat treatments. Distortion, warping, and cracking have been somewhat reduced. This may be due in part to reduction of maximum hardenability. However, it is believed that the smaller variation in the hardenability of steel obtained from different producing sources is an important factor.

One user reported that the better minimum hardenability of the H steels permitted the use of less drastic quenching, which again reduced distortion and cracking. It has also been reported that the use of H specifications has reduced the number of changes in tempering temperature, which are necessary to keep the steel products within hardness specifications.

While no reports are available with regard to effect of hardenability control upon service performance, it is certain that the elimination of the very small percent of steel which is inclined to result in low surface or cross sectional hardness, is a step in the right direction; it might bring about some reduction in the percent of service failures.

As a general rule, however, the percent of service failures is very low. Consequently it is difficult to arrive at a definite figure for the effect of hardenability control on service failures. As a general conclusion, it may be stated that the use of hardenability specifications does not change the average performance of steel parts, but that it does eliminate the extremely high and extremely low hardenability heats of steel, which formerly would have been accepted under chemical analysis specifications. In this way it reduces the small percent of trouble which was previously experienced.

Making Automotive Glass

Based on paper by
ROBERT A. MILLER
Pittsburgh Plate Glass Co.

FABRICATING each kind of bent automotive glass poses intricate problems. Cost is in direct proportion to manufacturing intricacy.

Gravity is essentially the only force that can be used for bending glass with required optical properties. Any contact of glass surface with the mould will affect the optical qualities to some extent, depending on the time-temperature curve followed in the bending process.

At a given temperature, glass will bend only a given amount in a given time. Smaller radii or deeper bend require higher temperatures. In making spheroidal bends, the glass must stretch. (Did you ever try to wrap a flat piece of paper around an orange?) Here again we need higher temperatures to get the glass sufficiently soft to flow. This especially subjects the glass to damage in case of any mould contact.

Since we depend on the uniform force of gravity to bend a beam of glass, maximum bending effect is at the center. Keeping the least radius at or near the center facilitates control of the glass. Minimum bends at other points are produced by tilting the mould, adding a part of the weight of the higher portion of the glass to the effective bending force.

The blanks must be considerably larger in bending a cone-shaped or cylindrical shaped piece cut transversely from the elements. This more nearly equalizes the spans to facilitate bending. The glass must be cut to finished size after bending, with considerable wastage resulting.

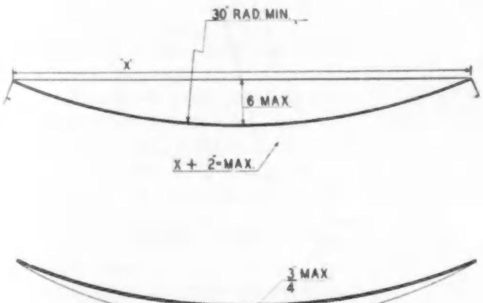
Because it is impossible to bend laminated safety glass, other limitations present themselves. Bending two or more glasses together at the same time introduces a tendency for the plates to fuse together. It's the usual practice to use some finely-divided parting material between the glasses. This limits depth of spheroidal shape or minimum radius in which laminated safety glass can be supplied. Reason: at higher temperatures the parting material will either damage the surfaces or will not prevent them from welding together.

Some bends can be made only by localized heating of the glass. This calls for heating the whole plate to nearly the softening point before starting localized heating. (It prevents plate breakage.) Unless annealing after bending is carefully controlled, the job is ruined.

Glass curves are classified into these five groups (see illustrations on this

CLASS I BENDS

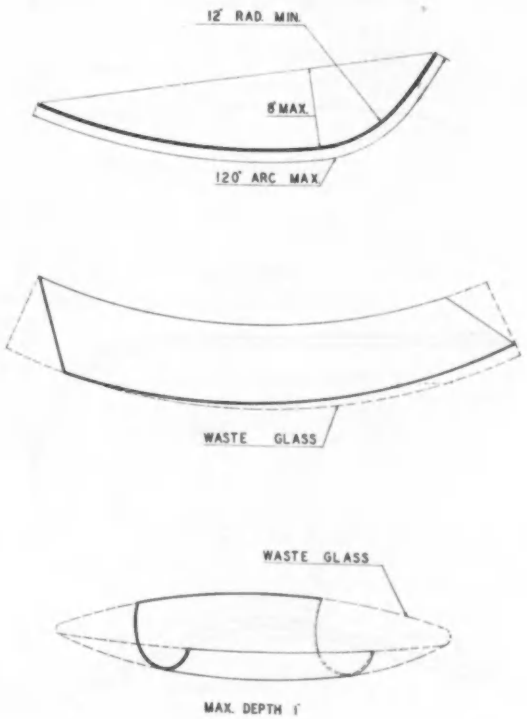
RELATIVE BENDING COST-1



ALL OUTLINES MUST BE ESSENTIALLY RECTANGULAR OR SYMMETRICAL ABOUT A CENTER

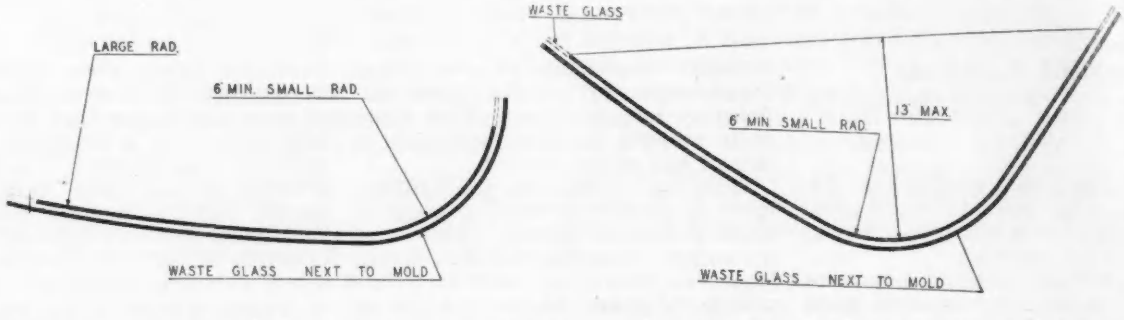
CLASS II BENDS

RELATIVE BENDING COST-1$\frac{1}{2}$-2



CLASS III BENDS

RELATIVE BENDING COST=2-4



page), depending on the methods of bending required for their fabrication:

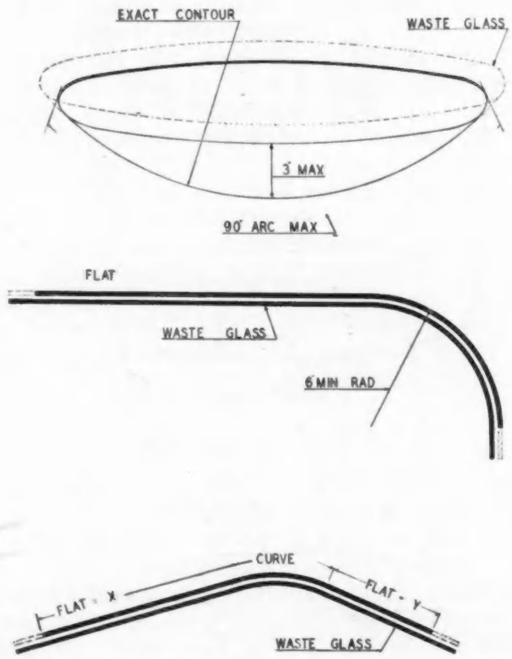
- Class I—This comprises the simplest bends, which may be cut to pattern before bending. They are bent on skeleton moulds.
- Class II—These may be bent on skeleton moulds, but must be cut to pattern after bending. Much glass is wasted.
- Class III—These bends are made on thin metal moulds contracting the entire surface. They require an extra piece of glass—as a buffer—between the finished and usable bend which is discarded after each operation.
- Class IV—Bends of this type are made on ceramic moulds contacting the entire surface. They require a buffer glass and must be made from large oversize blanks, cut to size after bending.
- Class V—Included here are especially intricate or warped curves involving two or more other processes. This calls for repeated heating, cooling, and cutting for as many as four different bending cycles.

This bend classification is based on the number of operations involved and thus is approximately on a cost basis. Bending is the chief reason for the cost difference between bent laminated glass and flat glass. At present (as the illustrations show), cost of bends varies from about twice that of flat glass for Class I to 25 times that for Class V.

Continuous research and greater experience have, and will continue, to reduce costs on certain bends. (Paper "Curved Glass for Automotive Uses," was presented at SAE Detroit Section, April 19, 1948. This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

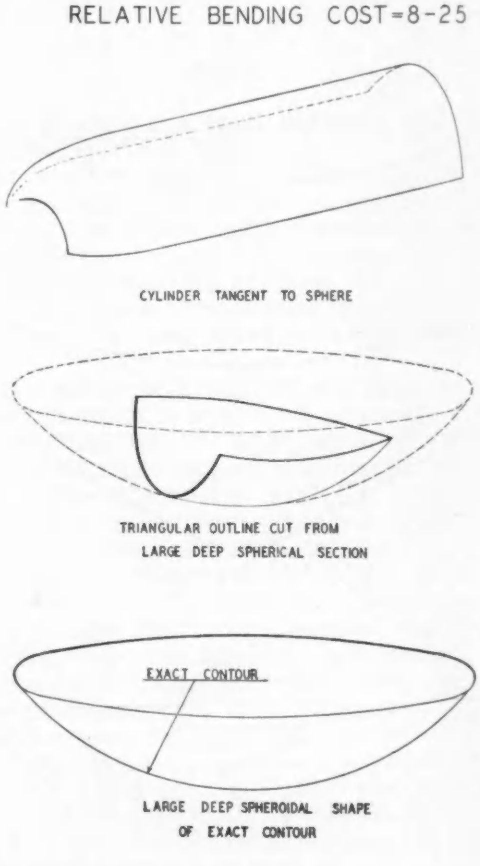
CLASS IV BENDS

RELATIVE BENDING COST=4-8



CLASS V BENDS

RELATIVE BENDING COST=8-25



Outlines Steps in Car Styling

From paper by
RAYMOND LOEWY
Raymond Loewy Associates

THE art of styling passenger car bodies, as practiced at South Bend, is an orderly, step-by-step process. Here's how the steps go:

1. The design staff is given an explanation of the design problem, blueprints of the chassis, and specifications for interior dimensions and clearances.
2. The design philosophy is established according to new ideas expressed by management, other manufacturers, and the public. The new ideas are combined with two eternal concepts: Weight is the stylist's enemy. The car must have styled-in forward motion to appear fast even when stationary.
3. Tasks are assigned to groups of designers. One group may do rough sketches of the entire car. Another group may work on the front and rear ends only. And other groups concentrate on other units. Results of their work are piles of rough sketches and several 1/8-size clay models. Designers are allowed to work in pencil or clay, as they choose, and together they assemble enough ideas for half a dozen cars.
4. Most promising designs are selected from the roughs. A good front treatment may be tried with a likely side elevation, or other combinations tried. Four or five of the resulting designs are sketched and modeled in clay to one-quarter scale.
5. Satisfactory clay models are cast in plaster and the plaster replicas are painted, trimmed with bumpers, door handles, and lucite headlights. Photographs of completed models are projected full-car size on screens so that the cars can appear to rest on ground. This procedure shows how production cars would look, without the cost of full-size mockups.
6. The best designs are chosen from the full-size projections and fashioned full-size in clay. Any distortions incurred in scaling up are corrected. Then plaster or wood mockups are built, painted, trimmed, equipped, and glazed to look like production jobs. All mockups to be shown together are painted the same color to eliminate color prejudices.

   Plaster mockups cost less, but wood mockups are more realistic because doors open and interiors can be finished.
7. Management makes the decision on the basis of the mockups. Spectators are assembled about 150 ft away from a veiled full-size model. Then the model is revealed to them suddenly in normal daylight. Here's where first impressions count; the design that looks alive on the first glance is the wise choice.

If management suggests changes—and inevitably it does—another showing is given after the changes have been made. Then at last, the final decision on design is made. (Paper "Body Styling Today," was presented at the SAE Detroit Section, Detroit, Dec. 17, 1947.)

Electronic Control Devised for Turbojets

From paper by
A. T. COLWELL,
Thompson Products, Inc.
F F. OFFNER,
Offner Products Corp. and
T. R. THOREN,
Thompson Products, Inc.

ONE answer to the problem of providing correct fuel flow to aircraft turbojet powerplants is the Thompson-Offner electronic control.

This is a governor capable of determining future values of both speed and temperature from their preceding rates of change. A single throttle lever in the cockpit controls the engine.

Fig. 1 shows the system. Speed is sensed by a special tachometer. A derivative term is developed from this tachometer and combined with the speed term. A temperature-sensing element, which may be a number of thermocouples in parallel, is used to generate the temperature signal. A temperature derivative signal is developed and combined with the temperature signal.

Speed and temperature signals are combined in the electronic selector, which chooses the signal required during the operation cycle. The resulting signal is amplified and applied to a proportional solenoid which actuates the servo valve to control the position of the balanced piston in the fuel flow control valve. High pressure fuel is the working fluid for the servo system.

The system employs a fixed displacement fuel pump whose outlet pressure is controlled by a relief valve. As a safety measure a solenoid-actuated overspeed restriction valve is provided downstream from the main control valve. This is normally wide open. A manually controlled shutoff valve is the last unit in the fuel circuit ahead of the nozzles. (Paper "Power Controls for Turbojet Engines," was presented at the SAE National Aeronautic and Air Transport Meeting, New York, April 15, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

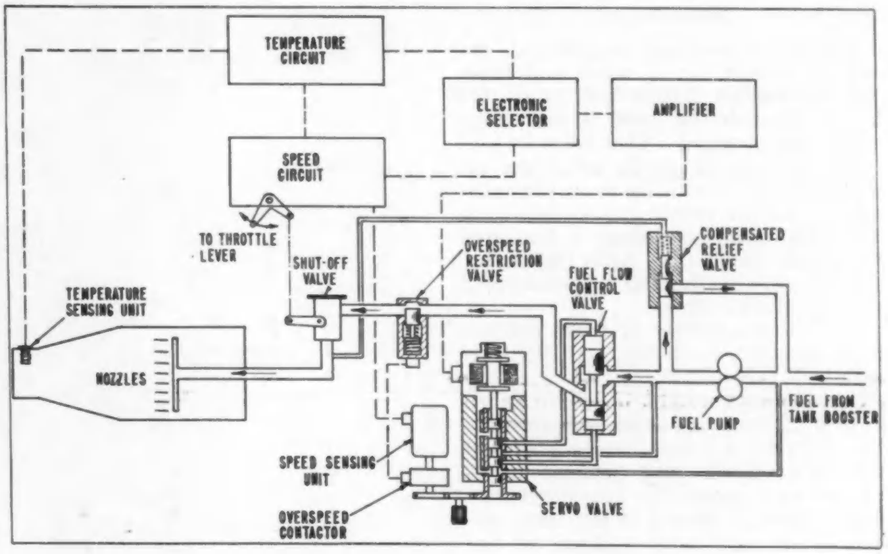


Fig. 1—Thompson-Offner electronic contol

New Nash Manifold Permits Leaner Mix

Excerpts from paper by

EARL L. MONSON

Nash Motors Division
Nash-Kelvinator Corp.

ITEM of interest in the Nash engine is the sealed-in type of intake manifold. This manifold is cast within the cylinder head of the L-head engine, virtually surrounded by water for temperature control.

Study of conventional manifolding reveals a wide spread of fuel mixture temperatures. Low car speeds in cold weather produce low mixture temperatures in the end ports, causing condensation and upsetting distribution. High-speed driving with full throttle operation brings high mixture temperatures because of exhaust manifold radiation.

Temperature Stabilized

The sealed-in manifold produces isothermal manifold wall conditions because of its water jacketing. This generally permits leaner part throttle mixtures and increases output at full throttle operation.

Fig. 1 shows these mixture temperatures. The solid line is a curve of temperatures under full throttle operation. The temperature drops as velocity increases. The dotted line indicates roadload mixture temperatures. The dash-and-dot curve gives data on a competitive engine under full throttle operation.

Note the upswing from 3000 rpm to maximum speed. This stems from exhaust manifold heat build-up and subsequent radiation to intake manifold. High temperature at the top end reduces mixture density resulting in a measurable output loss.

Details Design

Fig. 2 shows a section through the vertical centerline of block and head. The carburetor flange boss is on the head; through the head is the manifold inlet passage. This inlet is machined to size. Directly below the inlet passage is shown the center exhaust port. It is in direct contact with the manifold floor, providing a hot spot for quick warm-up. After warm-up, the hot spot temperature is controlled by surrounding water.

The warm-up time of these engines is no different than engines with conventional type manifolds.

Considerable weight has been saved on this engine. A recent weight study divulged that a competitive engine had 34½ lb of intake and exhaust manifolding and necessary appurtenances. Some weight is added to the Nash engine block and head because of the integral manifold, but not 34½ lb.

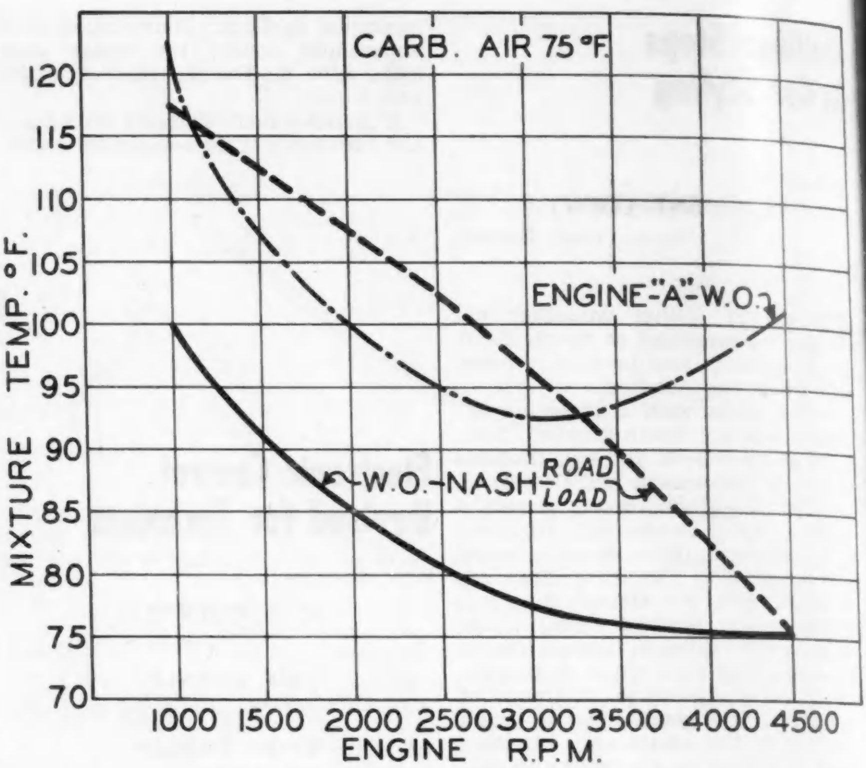
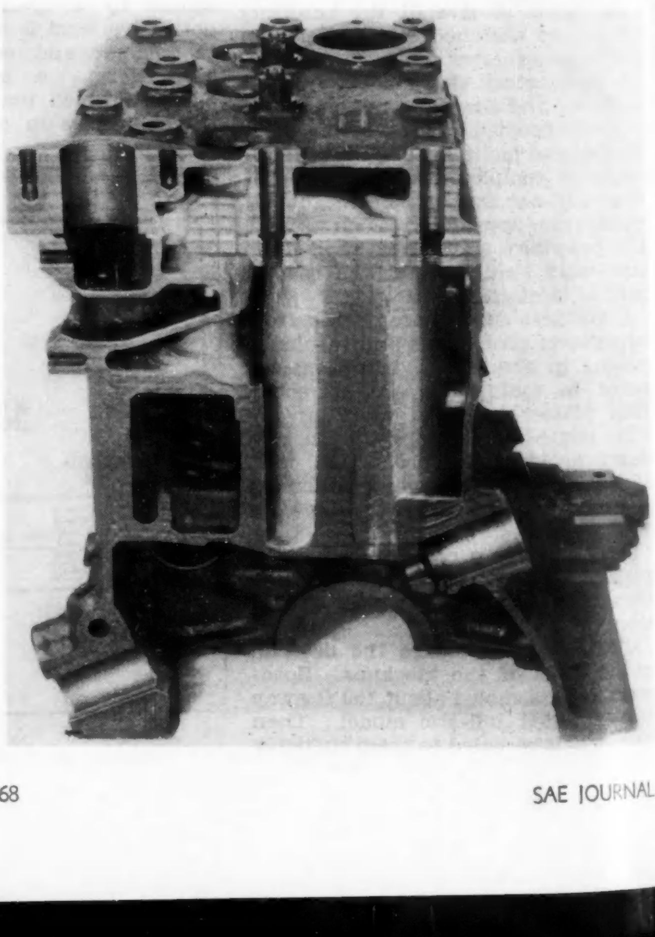


Fig. 1—Comparison of mixture temperatures of the Nash engine with sealed-intake manifold and that of a competitive engine with conventional manifolding

(Paper "Features of Nash Engines," was presented at SAE Summer Meeting, French Lick, June 9, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fig. 2—Section through the Nash engine showing manifolding cast within the block



New Travel Pleasure Built into Greyhound

Based on paper by

M. M. DEAN

The Greyhound Corp.

(This paper will be printed in full in SAE Quarterly Transactions.)

GREYHOUND'S experimental bus, the new Highway Traveler, is designed to treat passengers to greater travel pleasure at the lowest possible cost of operation per seat-mile.

Outstanding new features contributing to passenger comfort are the snack bar, drinking-water fountain, toilet, and head-rest radio speakers. Without disturbing fellow passengers, a seat occupant may listen to either of the two radio stations which the driver makes available—or he may shut off his speaker. The driver can make announcements through a public address system superimposed on the radio circuit. A passenger who wishes to read may touch a ceiling button to switch on an individual reading-light beam. There is also a conveniently located magazine rack.

Passengers have a choice of three compartments. One step up from the ground takes them to the 13-seat Sedan Lounge. Stairways inside the bus lead to the six-seat Fore Lounge beside the driver and the 31-seat Terrace Lounge behind him. Fig. 1 shows the arrangement. In all three compartments, newly designed, wider seats adjust immediately to a choice of reclining positions. Greater distance between seats gives passengers more leg room than present coaches afford.

Nonglare windows, 50% wider than those on present coaches, make the most of scenery. An air conditioning system circulates fresh air—warmed or cooled according to the season—through all sections of the bus.

Riding on the Highway Traveler is riding on air. Air-spring cylinders, two located near the front axle and four near the rear, plus sturdy rubber torsion springs mounted at the edges of the body, are said to provide the finest ride of any passenger-carrying vehicle yet developed. Air resistance in air-spring cylinders is adjusted automatically according to the weight of passenger load, so that the riding ease remains the same whether there is one passenger aboard or 50. Side sway is minimized because spring suspension points are comparatively high —very near the center of gravity.

Passengers seated on the upper level are well above the impact level. Passengers in the lower compartment are protected from possible sideswiping by a luggage section on one side and an aisle on the other.

All these advantages are provided for 50 passengers in a bus within the legal size and weight limitations under which present 37- and 41-passenger buses are designed. Only increase over dimensions of present standard equipment is a 14-in. increase in height, resulting in a body envelop 12% larger than standard.

Important in cutting operating costs is the fact that, besides carrying more passengers, the Highway Traveler carries them in less running time because the snack bar and toilet facilities eliminate meal and rest stops.

The bus is powered by twin aircooled engines designed specifically to promote operating efficiency. Normally, one engine propels the coach and the other drives the accessories. When extra power is needed, the power of the auxiliary engine is applied automatically to propulsion. This enables the bus to operate with equal efficiency in flat or mountainous country. In case of engine failure, either of the twin units can propel the bus to its destination, eliminating road delay.

Further safeguard against scheduling and road delays is the two-way radio communication, which permits interchange of scheduling information and reports of road failures.

The six large baggage compartments in the Highway Traveler permit segregation of long-haul and short-haul baggage and their accessibility speeds handling. (Paper "The Highway Traveler—Greyhound's New Intercity Bus," was presented at the SAE Summer Meeting, French Lick, Ind., June 7, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Advances Steer Diesel To Rail Power Supremacy

Based on paper by

J. W. BARRIGER

Chicago, Indianapolis and Louisville Railway Co.

MUCH hope is held that diesel locomotive developments will overcome the currently few advantages of steam power. Within sight are better diesel performance, flexibility, and lower initial cost which will almost completely outmode the steam locomotive.

There still remain some forms of service in which the steam locomotive holds comparative advantages . . . heavy transfer runs, acceleration of passenger trains in the higher speed ranges, and low-speed ascents of long, heavy mountain grades. But the margin of superiority is decreasing. Further development of the diesel engine and traction motor should give the diesel electric unit the lead over the entire range.

To pull up equal with steam performance in these three specific types of service, larger diesel engines will be built so that more than 2000 hp can be placed in one cab of a railroad locomotive. Present small-diameter driving wheels will be supplemented in future designs. Two large motors will turn each pair of wheels. Their in-

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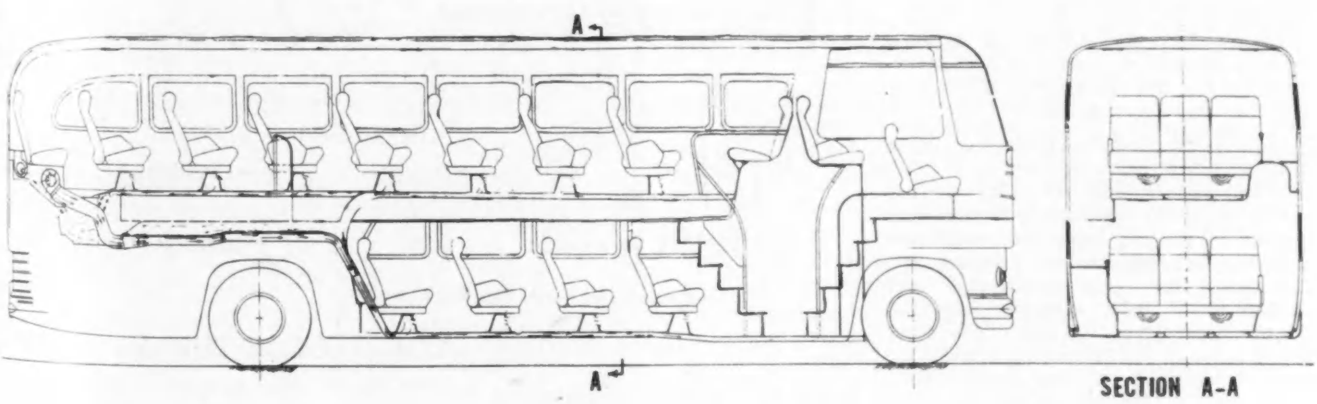

Fig. 1—Diagram of Greyhound Highway Traveler

creased individual and total power will be transmitted through the quill form of spring-cushioned drive to spokes of large-diameter driving wheels, carried in the main frame of the locomotive.

This fundamental design change must await larger diesel engines. But these will come and will give the locomotives they propel complete flexibility over a wide range of speed and power output. This form of diesel power will surpass best results with steam for all services.

Currently, 6000-hp diesel locomotives are about 250 ft. long and require support of 16 axles, if they consist of four 1500-hp cabs. Eighteen axles are needed—12 motorized and 6 idlers—if the pattern is three 2000-hp cabs.

I predict that 10 years from now, or perhaps much sooner, higher powered diesel locomotives will be no longer than 125 ft, and will consist of a single articulated unit.

Steam locomotives now transmit as much as 1000 to 1500 hp per axle, diesels no more than 400 hp. While this difference underlies the high initial-starting tractive effort of the diesel, in itself it is of no practical value when it exceeds capacity of car drawbars to transmit it.

Nearing Steam Advantages

Much of the diesel's inherently large starting tractive effort can be sacrificed, if need be, to reduce locomotive length and to remove all time limitation on slow speed operation with high drawbar pull. As diesel lengths shrink and their overall weight per horsepower decrease, power transmission per axle will approximate that of the steam locomotive.

Initial cost for the diesel locomotive is still high. A 1000-hp yard switcher sells for $95 per hp and road power for fast passenger service at around $100 per hp. Steam costs about half of diesel power, electric locomotives about two-thirds of it. Higher price of the diesel relative to its competitors stems from the need to provide complete power equipment in each of its three components—the diesel engine, the generator, and the traction motors.

Steam has the advantage of first cost, although the ratio is less favorable than a decade ago when the proportion was three to one.

Despite the first cost handicap, diesel railway power advanced partly because of fuel, repair, and servicing savings and principally because of availability, expressed in long runs and minimum layovers between them. (Paper "Super-Power for Super-Railroads," was presented at SAE Summer Meeting, French Lick, June 10, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

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TECHNICAL COMMITTEE PROGRESS

Viscosity Ratings for Torque Converter Fluids

by George A. Round

Chairman, Subcommittee on Torque Converter Fluids, SAE Fuels & Lubricants Technical Committee

FOR the past seven months a subcommittee of the SAE Fuels & Lubricants Technical Committee has been considering the feasibility of establishing a system of viscosity classifications for fluids for torque converters and hydraulic couplings.

As a result of discussions with various designers and builders of this equipment, and also companies supplying fluids for them, the subcommittee has released the following information which it believes will be of interest, not only to users of torque converters and fluid couplings, but also to those who are working on new designs.

At present, the manufacturers of torque converters for commercial vehicles and those who build these units for industrial equipment differ in their recommendations regarding the fluids to be used in their respective designs. To date, it has been impossible to secure agreement between them on a single fluid of sufficiently narrow range to be covered by one viscosity number.

In the present stage of development of torque converters for passenger cars, their requirements appear to be met by oils coming within the viscosity ranges of the present motor oil classifications—particularly SAE 10-10W and SAE 20-20W. The

same applies also to fluid couplings for both automotive and industrial use.

Since the SAE viscosity classifications for engine oils are now being studied and may be revised, it appears to the subcommittee unwise at present to recommend any viscosity classification for torque converter fluids and hydraulic coupling oils based on the present SAE viscosity number ranges.

In connection with the design and development of new equipment, the subcommittee has called attention to the fact that in the viscosity range below that of the lightest SAE 10-10W oils, there are available commercially, oils in the range of 80 to 100 SUS and having satisfactory low temperature viscosity characteristics which are worthy of study. Fluids for torque converters used in commercial vehicles have viscosities in the range of 58 to 63 SUS at 100F (approximately 10 to 11 centistokes) and are obtainable from a number of leading oil companies.

Fluids meeting the requirements of industrial torque converters and coming in the range of 34.4 to 37.6 SUS at 100F (2.5 to 3.5 centistokes) are also available to a limited extent.

The subcommittee believes that it would be advantageous in every way for designers to work with fluids in the ranges mentioned. From a performance standpoint, any effects of viscosity differences less than those between the oils and fluids mentioned would be nullified by relatively small changes in temperature. Recommendations for fluids of intermediate viscosity would only complicate distribution and marketing problems for the oil companies. It is therefore unlikely that they would become available generally since the volume demand would be small.

Members of the subcommittee are: G. A. Round, Socony-Vacuum Oil Co., chairman; A. H. Deimel, Spicer Division, Dana Corp.; H. C. Gooch, Tide Water Associated Oil Co.; J. D. Klinger, Chrysler Corp.; C. J. Livingstone, Gulf Research & Development Co.; J. M. Miller, Standard Oil Co. of Indiana; R. M. Schaefer, Allison Division, GMC; W. F. Shurts, Twin Disc Clutch Co.; H. R. Wolf, Research Laboratories Division, GMC; and R. N. Neldon, American Blower Co.

Technishorts • • •

FIFTH WHEELS: The SAE Tractor Semitrailer Connections Subcommittee is trying to determine what interference distances can be tolerated with different fore and aft positions.

SCREW THREADS: Representatives of the United States, Britain, and Canada have held two meetings this summer to near agreement on a unified screw thread system for the three countries. American and British proposals were brought to closer conformity. The conferees hope to iron out remaining differences at a meeting during the latter part of this year to evolve an international standard.

SUPPRESSORS: A standard test for distributor cap, spark-plug, and ignition lead suppressors is being developed by the External Suppressors Subcommittee of the SAE Electrical Equipment Committee. These suppressors are being incorporated in vehicle ignition systems to curb radiation which interferes with television and high-frequency radio reception.

TIRE-ROAD FRICTION: How to determine the friction between a vehicle tire and a road surface is the subject of a report now being prepared by the SAE Highways Research Committee, chairmanned by A. M. Wolf. Also to be included is a section on the use of a decelerometer.

RADIATOR TERMINOLOGY: Names of vehicle radiator types and parts are being defined by a group of the SAE Motorcoach and Motor Truck Committee. This nomenclature standard will include drawings of the several radiator types, with each part labelled.

MARINE STANDARDS: G. L. McCain, Chrysler Corp., chairman of the SAE Marine Propeller Shaft and Coupling Committee, recently activated two subcommittees. One is to revise standards for marine propeller shaft ends and wheel hubs; the other, those for marine propeller shaft couplings. The revised standards will replace those presently in the Handbook, adopted by SAE in 1929 and revised in 1935.

FLASH!

James F. Lincoln, one of the nation's outstanding manufacturing executives, president of Lincoln Electric Co., and a vigorous civic leader in his community, will be the speaker Friday, Oct. 22, at the SAE National Production Meeting & Clinic, Statler Hotel, Cleveland.

He will compare production in this country and Europe.

General chairman will be J. E. Hacker, and A. T. Colwell will be toastmaster.

The technical feature of the two-day program will be the All-Day Production Clinic Oct. 22, under the chairmanship of R. F. Steeneck, who introduced this plan a year ago.

Organized panels will be held on Die Casting and Plating, Gears, Inspection and Quality Control, Material Handling, Metallurgy and Heat Treatment, Production Control, and Welding.

The 41 panel leaders and members of these seven groupings include company presidents, vice-presidents in charge of production, production superintendents, works managers, and executive engineers.

The meeting opens Thursday, October 21, with an afternoon session at Hotel Statler with papers on quality control and the Antioch foundry process program, by J. N. Berretoni, industrial engineer, and E. A. Canning, Allison-Bedford Foundry, respectively.

F. C. Pyper and A. G. MacDougal, Buick Motors Division, General Motors Corp., will present a paper that evening on Manufacture of the Dynaflow.

Standards Makers Study Plane Circuit Breakers

WIDE difference of opinion among industry engineers on how aircraft circuit breakers should be used has energized a project on circuit breaker application standards. A group under the SAE Aircraft Electrical Equipment Committee will tackle the job.

Program of work laid out for the subcommittee, headed by J. Ottmar, Spencer Thermostat Co., covers the following assignments:

(1) Collect data and specifications on circuit breakers now in use. (2) Assemble data and specifications on cable performance. (3) Gather all available data on 120-v systems used in other equipment, such as submarines. (4) Arrange a meeting of the subcommittee with Air Force and Bureau of Aeronautics Personnel to review data collected, and to determine how the subcommittee can be most useful toward helping improve circuit breaker performance and specifications.

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Hawaii

Chairman: **John C. McLaughlin**, depot manager, U. S. Navy, Yards & Docks Supply Depot, Parts Division, Naval Supply Center.

Vice-chairman: **Clyde A. Ahlf** superintendent, Transportation Division, Hawaiian Pineapple Co., Ltd.; vice-chairman Aeronautics; **Stephen J. Miehlstein**, superintendent of maintenance, Hawaiian Airlines, Ltd.; vice-chairman Hawaii: **Daniel Thompson**, superintendent, Automotive Equipment, Hamakua Mill Co.; vice-chairman Maui: **John E. Walker**, superintendent of transportation, Hawaiian Commercial & Sugar Co., Ltd.; treasurer: **Arthur G. Kruse**, manager, Electric Steel Foundry; secretary: **Dr. E. G. McKibben**, head, Department of Agricultural Engineering, Pineapple Research Institute.

Indiana

Chairman: **Raymond A. Schakel**, manager, Auto & Diesel Drive Division Diamond Chain Co., Inc.

Vice-chairman: **Dim Gerdan**, chief engine engineer, Allison Division, General Motors Corp.; treasurer: **Wayne H. McGlad**, process engineering manager, J. D. Adams Mfg. Co.; secretary: **Robert P. Atkinson**, assistant turbine engineer, Allison Division, General Motors Corp.

Kansas City

Chairman: **Robert A. Walker**, director, Aircraft Engineering, Trans World Airline, Engineering Department.

Vice-chairman: **Harold W. Twyman**, mechanical engineer (Aircraft Powerplants), Civil Aeronautics Administration, Department of Commerce; vice-chairman Aeronautics: **Louis R. Koepnick**, chief engineer, Trans World Airline; vice-chairman Fuels & Lubricants: **H. E. Toot**, chief chemist, Phillips Petroleum Co.; vice-chairman Transportation & Maintenance: **Howard F. Dougherty**, transportation shop foreman, Kansas City Power & Light Co.; treasurer: **Byron L. Weiss**, automotive engineer, Socony-Vacuum Oil Co., Inc.; secretary: **Frederick V. Olney**, superintendent of transportation, Gas Service Co.

Metropolitan

Chairman: **Richard C. Long**, Eastern representative, Warner Electric Brake Mfg. Co.

Vice-chairman: **Richard Creter**, general service manager, Cummins Diesel Railroad Equipment Co., Inc.; vice-chairman Aeronautics: **S. G. Nordlinger**, director of sales, Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corp.; vice-chairman Air Transport: **Kenneth Murdock**, assistant secretary, American Overseas Airlines, Inc.; vice-chairman Diesel Engines: **Joseph A. Foss**, American Bosch Corp.; vice-chairman Fuels & Lubricants: **John Edward Schipper, Jr.**, sales engineer, National Carbon Co.; vice-chairman Passenger Cars: **Charles S. Herrmann**, New Jersey Bell Telephone Co.; vice-chairman Students: **Neil P. Flynn**, research engineer, Standard Oil Co. of N. J.; vice-chairman Transportation & Maintenance: **Harvey H. Earl**, superintendent, Motor Equipment, United Parcel Service of N. Y., Inc.; treasurer: **Robert A. Cole**, project engineer, Wright Aeronautical Corp.; secretary: **Frank J. Ott**, division supervisor, M. V., New Jersey Bell Telephone Co.

Mid-Continent

Chairman: **George W. Cupit, Jr.**, state chemist, Corporation Commission, State of Oklahoma.

Vice-chairman: **Raymond G. Hilligoss**, manager, Bartlesville Bus Co; vice-chairman Transportation & Maintenance: **Harold C. Baldwin**, sales engineer, Continental Oil Co.; treasurer: **Delton R. Frey**, lubrication engineer, Anderson-Prichard Oil Corp.; secretary: **William K. Randall**, sales engineer, Carter Oil Co.

Milwaukee

Chairman: **Gene D. Sickert**, works manager, Bolens Products Division, Food Machinery Corp.

Vice-chairman: **George J. Haislmaier**, sales manager, Young Radiator Co.; treasurer: **Charles Henry Duquemin**, field engineer, Le Roi Co.; secretary: **Howard M. Wiles**, research engineer, Waukesha Motor Co.

New England

Chairman: **Elty C. Guiou**, M. V. supervisor, New England Telephone & Telegraph Co.

Vice-chairman: **Ernest K. Bloss**, mechanical engineer, Boston & Maine R. R.; vice-chairman Aeronautics: **Charles E. Batstone**, sales engineer, Brockway Motor Co.; vice-chairman Diesel Engines: **Arthur W. Wanzer**, chief engineer, Murray & Tregurtha, Inc.; vice-chairman Fuels & Lubricants: **Lewis P. Hankins**, superintendent of equipment, and purchasing agent, Hemingway Brothers Interstate Trucking Co.; vice-chairman Passenger Cars: **Frank W. Marshall**, service manager, Noyes Buick Co.; vice-chairman Students: **David A. Fisher**, assistant professor, Mechanical Engineering, Tufts College; vice-chairman Transportation & Maintenance: **B. D. Connor**, superintendent, Transportation, Boston Consolidated Gas Co.; vice-chairman Truck & Bus: **Willard H. Head, Sr.**, automotive superintendent, Public Service Co. of N. H.; treasurer: **Neal E. Bogren**, president, Waltham Automotive Corp.; secretary: **William F. Hagenloch**, president, Lenk, Inc.

Northern California

Chairman: **Roy A. Hundley**, chief engineer, Enterprise Engine & Foundry Co.

Vice-chairman: **Harry N. Taylor**, superintendent, powerplant engineering, United Air Lines, Inc.; vice-chairman Aeronautics: **William V. Hanley**, assistant manager, Aviation Division, Standard Oil Co. of California; vice-chairman Diesel Engines: **John Seagren**, chief engineer, Atlas Imperial Diesel Engine Co.; vice-chairman Fuels & Lubricants: **Edward J. McLaughlin**, supervisor Engine Fuels Division, California Research Corp.; vice-chairman Transportation & Maintenance: **Leland S. Prior, Jr.**; treasurer: **Carl W. Spring**; secretary: **Henry M. Hirvo**, chief draftsman, Enterprise Engine & Foundry Co.

Northwest

Chairman: **Russell E. Fleischer**, district manager, Colyear Motor Sales Co.

Vice-chairman: **Paul P. Olson**, home office engineer, General Petroleum Corp.; treasurer: **Roy T. Severin**, manager, partner, Gasoline Tank Service Corp.; secretary: **C. Fred Naylor**, sales coordinator, Ethyl Corp.

Oregon

Chairman: **John Stanley Poulson**, assistant secretary, Cummins Diesel Sales of Oregon, Inc.

Vice-chairman: **Floyd D. Chapman**, sales manager, Parts Department, Roberts Motor Co.; vice-chairman Aviation: **Charles Henry Lewis**, head fuel & lubricant engineer, Standard Oil Co. of California; vice-chairman Fuels & Lubricants: **J. L. Phelps**, lube engineer, Texas Co.; vice-chairman Marine: **L. C. Fogg**, Western Wax Paper Co.; vice-chairman Students: **William H. Paul**, professor, Automotive Engineering, Oregon State College; vice-chairman Tractors: **Powers Wickes**, chief engineer, Interstate Tractor & Equipment Co.; vice-chairman Transpor-

tation & Maintenance: **Edgar B. Ogden**, superintendent of shops, Consolidated Freightways, Inc.; vice-chairman Truck & Bus: **Louis Stevens**, general shop foreman, shop superintendent, Wentworth & Irwin, Inc.; treasurer: **Clarence Bear**, fleet superintendent of maintenance, Hudson-Duncan & Co.; secretary: **Ray Mobley**, parts manager, Wentworth & Irwin, Inc.

Philadelphia

Chairman: **Parry H. Paul**, technical service engineer, Autocar Co.

Vice-chairman: **Leonard C. Raymond**, assistant supervisor, Automotive Division, Socony-Vacuum Oil Co., Inc.; vice-chairman Aircraft: **Hugh J. Mulvey**, chief of stress, Piasecki Helicopter Corp.; vice-chairman Fuels & Lubricants: **J. P. Stewart**, automotive consultant, Research & Development Labs., Socony-Vacuum Labs., Division of Socony-Vacuum Oil Co., Inc.; vice-chairman Transportation & Maintenance: **Chester W. Engel**, superintendent, Motor Equipment, Gulf Oil Corp.; vice-chairman Truck & Bus: **B. Frank Jones**, chief engineer, Autocar Co.; treasurer: **Linn Edsall**, general superintendent, Transportation Division, Philadelphia Electric Co.; secretary: **Laurence Cooper**, chassis engineer, Autocar Co.

Pittsburgh

Chairman: **Charles W. Woods**, coordinator of transportation, West Penn Power Co.

Vice-chairman: **Otto Walter**, vice-president, general manager, Truck-Trailer Sales & Service Co.; vice-chairman Oil City: **Charles R. Scott**, lubrication engineer, Wolf's Head Oil Refining Co., Inc.; treasurer: **Warren J. Iliff**, superintendent, maintenance, Equitable Auto Car.; secretary: **J. Edward Taylor**, assistant chief automotive engineer, Gulf Research & Development Co.

St. Louis

Chairman: **Adolph J. Jeude**, assistant chief engineer, Busch-Sulzer Bros.—Diesel Engine Co., Division, Nordberg Mfg. Co.

Vice-chairman: **W. E. Lang**, service engineer, Acheson Colloids Corp.; vice-chairman Aircraft: **Niels C. Beck**, associate dean, Parks College of Aeronautical Technology of St. Louis University; vice-chairman Diesel Engines: **Archie K. Miller**, sales engineer, Socony-Vacuum Oil Co., Inc.; vice-chairman Fuels & Lubricants: **Warren H. Cowdery**, industrial representative, Sinclair Refining Co.; vice-chairman Transportation & Maintenance: **Monroe C. Alves**, superintendent of motor transportation, Union Electric Co. of Missouri; treasurer: **W. S. Rigby**, design engineer, Wagner Electric Corp.; secretary: **Roy T. Adolphson**, captain, development engineer, Sunnen Products Co.

San Diego

Chairman: **Daniel S. Sanborn**, consultant engineer, owner, D. S. Sanborn Engineering.

Vice-chairman: **William H. Rhodes**, district manager, Imperial Hay Growers Association; treasurer: **Theron F. Brown**, general superintendent, San Diego Electric Ry. Co.; secretary: **Hamilton L. Stone**, assistant professor, Department of Physical Science, San Diego State College.

Southern California

Chairman: **James W. Sinclair**, manager, Automotive Department, Union Oil Co. of California.

Vice-chairman: **Reagan C. Stunkel**, president, Aviation Maintenance Corp; vice-chairman Air Transport: **Charles F. Thomas**, sales engineering, manager, Lockheed Aircraft Corp; vice-chairman Aircraft Engines: **Fred O. Hosterman**, hydraulics design specialist, Lockheed Aircraft Corp.; vice-chairman Aircraft Powerplant: **T. N. Baker**, engineering representative, Allison Division, General Motors Corp.; vice-chairman Diesel Engines: **Tom J. Collins**, regional manager, Western Area, Buda Engine Co.; vice-chairman Fuels & Lubricants: **Robert R. Mead**, field engineer, Ethyl Corp.; vice-chairman Passenger Cars: **James A. Hodges**, zone fleet service manager, Chevrolet Motor Division, General Motors Corp.; vice-chairman Transportation & Maintenance: **Calvin T. Thomas**, supervisor, Automotive Equipment, General Petroleum Corp.; vice-chairman Truck & Bus: **William G. Letts**, fire apparatus test & development engineer, Mack International Motor Truck Corp.; treasurer: **Edward E. Tuttle**, partner, Tuttle & Tuttle; secretary: **Charles L. Fernau**, special representative, Standard Oil Co. of California.

Southern New England

Chairman: **David E. Waite**, contact engineer, Wallace Barnes Co.

Vice-chairman: **John J. Broderick**, project engineer, American Bosch Corp.; vice-chairman Aeronautics: **W. Paul Eddy, Jr.**, chief engineering Operations, Pratt & Whitney Aircraft Corp.; treasurer: **Henry J. Fischbeck**, supervisor, Metallurgical & Chemical Processing, Pratt & Whitney Aircraft Division, United Aircraft Corp.; secretary: **Claude Owen Broders**, designer, Pratt & Whitney Aircraft Division, United Aircraft Corp.

Spokane-Intermountain

Chairman: **William B. Keith**, service manager, Spokane Kenworth Co.

Vice-chairman: **Louis P. Johnson**, salesman, Colyear Motor Sales Co.; treasurer: **Peter J. Favre**, instrument engineer, Inland Empire Refinery; secretary: **John F. Conner**, shop superintendent, Auto Interurban Co.

Syracuse

Chairman: **Samuel K. Wolcott, Jr.**, engineer in charge of engines and pumps, American La France Foamite Corp.

Vice-chairman: **Curtis R. Armbrust**; vice-chairman Elmira-Ithaca: **Edwin B. Watson**, associate professor of mechanical engineering, Cornell University; treasurer: **Carl T. Doman**, vice-president, chief engineer, Aircooled Motors, Inc.; secretary: **William F. Burrows**, chief project engineer, Aircooled Motors, Inc.

Texas

Chairman: **James W. Walker**, director, Walker Laboratories.

Vice-chairman: **John T. Wade**, superintendent, Auto Equipment, Texas Power & Light Co.; vice-chairman Activity: **Hornell G. Erickson**, structural design engineer, CAA engineering representative, Luscombe Airplane Corp.; vice-chairman Regional: **E. J. Strawn**, regional automotive supervisor, Shell Oil Co., Inc.; treasurer: **Earl L. Casey**, general superintendent of production & maintenance, Geophysical Service, Inc.; secretary: **Edward C. Steiner**, chief engineer, OEM Industries.

Twin City

Chairman: **J. C. Hoiby**, chief engineer, D. W. Onan & Sons, Inc.

Vice-chairman: **Thomas E. Murphy**, assistant professor of mechanical engineering, University of Minnesota; treasurer: **Frank A. Donaldson, Jr.**, vice-president, Donaldson Co., Inc.; secretary: **Robert J. Strouse**, bus manager, Northwestern District, Mack-International Motor Truck Corp.

Virginia

Chairman: **Paul R. Lauritzen**, president, Lauritzen Motors, Inc.

Vice-chairman: **J. D. Lawrence, Jr.**, general manager, National Oil Corp.; treasurer: **Percy J. Carr**, president, Carr-Woodall Tire Service, Inc.; secretary: **Seldon L. Baird**, president, Fairfield Transit Co.

Washington

Chairman: **E. K. Owens**, field engineer, U. S. Rubber Co.

Vice-chairman: **Harold W. Evans**, chief engineer, Tank & Motor Transport Division, Research & Development Service, U. S. Army, Office, Chief of Ordnance; treasurer: **Bertram Ansell**, partner, Ansell & Goda; secretary: **H. A. Roberts**, president, G. M. Roberts Brothers Co.

Western Michigan

Chairman: **Willis R. Johnson**, sales engineer, Campbell Wyant & Cannon

Foundry Co.
Vice-chairman: **William A. Wiseman**, assistant chief engineer, Continental Motors Corp.; treasurer: **George E. Dake, Jr.**, Sales Department, Fitzjohn Coach Co.; secretary: **L. W. Kibbey**, product engineer, Sealed Power Corp.

Wichita

Chairman: **Walter E. Burnham**, staff engineer, Beech Aircraft Corp.
Vice-chairman: **Marvin J. Gordon**, chief of aerodynamics, Beech Aircraft Corp.; treasurer: **Virgil W. Hackett**, chief draftsman, Cessna Aircraft Co.; secretary: **M. L. Carter**, chief chemist, Southwest Grease & Oil Co., Inc.

British Columbia Group

Chairman: **Harold Puxon**, managing director, Columbia Trailer Co., Ltd.
Vice-chairman: **A. Gordon Scott**, sales manager, B. C. Division, Imperial Oil, Ltd.; treasurer: **William H. Welsh**, service manager, Begg Motor Co., Ltd.; secretary: **Burdette Trout**, sales, Truck Parts & Equipment, Ltd.

Colorado Group

Chairman: **Richard S. Arnold**, partner, Arn-Wood Co.
Vice-chairman: **Edgar Lee Elder**, owner, Elder Trailer & Body Service; treasurer: **Robert W. Porter**, owner, Porter Crankshaft & Bearing Service; secretary: **Stephen G. Scott**, truck manager, Fenner Tubbs Co.

Mohawk-Hudson Group

Chairman: **Robert H. Craig**, new car sales manager, Albany Garage & Appliance Distributors, Inc.
Vice-chairman: **Edgar I. Billings**, sales engineer, Socony-Vacuum Oil Co., Inc.; secretary-treasurer: **Carl M. Myers**, fleet salesman, Reo Motors, Inc.

Salt Lake Group

Chairman: **David Brown**, Parts Department, manager, Cummins Intermountain Diesel Sales Co.
Vice-chairman: **Frank G. Backman**, manager, Midwest Service & Supply Co.; secretary-treasurer: **Harold C. Slack**, service manager, Fruehauf Trailer Co.

Williamsport Group

Chairman: **G. Allen Creighton**, special problems engineer, Lycoming Division, Avco Mfg. Corp.
Vice-chairman: **Robert B. Ingram**, assistant supervisor engineer, Lycoming Division, Avco Mfg. Corp.; treasurer: **James C. McRoberts**, assistant project engineer, Lycoming Division, Avco Mfg. Corp.; secretary: **John W. Hospers**, analytical engineer, Lycoming Division, Avco Mfg. Corp.

SAE Section C

LAMB
. . . . of Detroit

Ernest P. Lamb, chief engineer of Dodge Truck Division, is calm, cosmopolitan, competent.

Calm—he has to be! On the day the Journal phoned him for information for this sketch, Ernie's plant had no water, electricity, steam, or telephone service because an excavating

Ernest P. Lamb

job had accidentally snafued all the utilities and services. Ernie is used to that—his home has been struck by lightning, scorched by fire, and damaged by smoke from the heating plant. Ernie was shaving when the lightning hit. His calm stood him in good stead during these emergencies, just as it had when speakers failed to arrive or other mishaps threatened SAE meetings during his terms as vice-chairman and secretary.

Cosmopolitan—he travels whenever he gets the chance and is almost as much an advocate of automobile travel as the pioneers of the Lincoln Highway. Even his 15-year-old son has this interest, too; he has just completed an 8000-mile station wagon trip with other youths. (Incidentally, daughter, 19, is a junior at Wellesley.)

Competent—he's a product of Detroit schools, Detroit Institute of Technology, and the application of a real engineering mind to his daily tasks. Ernie personifies the answer to the question "How does that fellow get there?" Well, in the first place, he's been active on SAE committees almost from the days when the choke wire stuck out in front of the radiator beside the crank. He's been a member of a long list of SAE committees and AMA committees on transportation engineering, vehicle nomenclature, trucks, buses, brakes, and fuel tanks. He regards SAE as a fine professional proving ground for any man, and the source of a great many friendly social contacts that make life worth living.

Besides his other responsibilities, he has been nominated to be SAE Vice President representing the Truck and Bus Activity for 1949.

—William F. Sherman, Field Editor

HOERTZ
. . . . of Cleveland

Norman Hoertz's engineering career to date has almost paralleled his activity in SAE affairs.

Directly upon graduation from Case Institute of Technology with a BS in mechanical engineering, he joined Thompson Products, Inc., in 1932. He started in production engineering, was transferred to machine and tool design, and later did extensive product research and development work for the company.

By 1937 he was named general service manager, and today is chief engineer of Thompson's Service Divisions.

Not only has he been an active worker in the interest of the Cleveland Section, but he has widened his activity in the national organization. As chairman of the Engine Valve Group of the SAE Ordnance Vehicle

Norman Hoertz

Chairmen

Maintenance Committee on Reclamation of Parts he and his co-workers won high praise from the Chief of Ordnance of the U. S. Army. He has served as vice-chairman of the SAE Student Committee, and was a member of the SAE T & M Committee on Reconditioning of Connecting Rods, a project requested by both the Office of Defense Transportation and the Army Ordnance Department.

Immediately following the war he spent four months in Europe as a member of the Automotive Division of the Government's Technical Industrial Intelligence Committee studying technological development achieved by German industry and military establishments.

His personality has won for him a host of friends. For recreation he favors golf and fishing.

CHURCHILL

. . . . of Chicago

Research engineer by profession and agriculturist by avocation, H. E. Churchill is one of those unusual people who keeps knowing more and more about more and more as the years go on. He is a research man interested not only in the techniques of what makes mechanisms go right or go wrong, but also in the broad aspects of engineering and the people who carry it on.

He is a specialist on transmissions, axles, steering and ride control of passenger cars; an avocational expert on various phases of agriculture; and an ever-effective worker in the vineyard of SAE activities.

His twenty-odd year association with Studebaker Corp. was preceded by three years as a teacher of mathematics and drawing and a year on chassis design at Dodge.

Now he is Studebaker's chief research engineer and a member of the five-man engineering operating committee which, under the direction of Vice-President Stanwood W. Sparrow, is responsible for the corporation's engineering policies.

He played an important part in development work on the famous Weasel during World War II, and in other projects undertaken for the Ordnance Department.

Before taking over his post as 1948-49 Chicago Section Chairman, "Church" had served the Section as a vice-chairman for passenger cars, and as secretary. He has authored a number of technical papers presented before national meetings of the Society and is active in SAE technical committee work.

H. E. Churchill

You'll Be Interested To Know • • •

FRANK E. FARRELL took permanent possession of the SAE Championship Golf Cup (which had been in competition for 20 years) at a presentation ceremony staged by the Chicago Section at its Play Day outing on Sept. 24. Farrell retired the trophy with three successive wins in 1946-47-48. Eleven other names are on the cup, A. T. Colwell's appearing twice. Scheduled to make the presentation was 1948 Golf Committee Chairman W. K. Creson—who negotiated a hole-in-one for himself just a few weeks prior to the gathering.

Frank E. Farrell (left)

W. K. Creson (right)

SAE WAS REPRESENTED by Henry Lowe Brownback at the Congress of the Associazione Tecnica dell'Automobile at Turin, Italy, last month. He bore an official message from SAE President R. J. S. Pigott which read in part: "Your confreres in automotive engineering the world over are looking to you for accomplishment of great things in the field of automotive transportation. In this professional endeavor our Society is happy to offer its cooperation."

IN ENGLAND last month, SAE Past Vice-President Harold R. Harris was official SAE representative at the Flying Display and Exhibition of the Society of British Aircraft Constructors.

THE 1948 DANIEL GUGGENHEIM MEDAL award is being made this year at the SAE National Aeronautic Meeting in Los Angeles on Oct. 8. Winner is SAE member Leroy R. Grumman, chairman of the board, Grumman Aircraft Engineering Co.

ABOUT 90% of all dues-paying SAE members belong to one or another of the Society's 38 Sections and Groups. The remaining 10% includes foreign members. . . . About half of these members belong to the five largest Sections—Detroit, Metropolitan, Southern California, Chicago and Cleveland, which, according to a July 19, 1948 count ranked in the order mentioned. . . . Southern California boasts, in addition, 500 enrolled students second only to Detroit's 879. Metropolitan has 331 enrolled students, Cleveland 258, and Chicago 204. Colorado Group, with 31 students and 62 dues-paying members has the highest student-to-member ratio.

J. VERNE SAVAGE plans to re-enter automotive engineering work after taking a year's vacation following his retirement as superintendent of Transportation and Maintenance of the City of Seattle. Savage's retirement marked completion of 30 years in the city's service, during which he designed, installed and operated one of the country's pioneer Inspection Stations—an operation which drew widespread automotive interest. Since 1928, he has been active in SAE. He served a two-year term as a councilor, seven years on the T&M Activity Committee, three terms as chairman of the Seattle Section, and authored several technical papers.

FRED M. YOUNG, president and general manager of Young Radiator Co., Racine, Wis., was presented with an Achievement Award at a dinner sponsored by the Wisconsin Centennial Automotive Committee on Aug. 13 at Milwaukee. He received this award in recognition of his "outstanding contribution to the Automotive Industry of Wisconsin during Wisconsin's first 100 years of statehood." The Young Radiator Co. recently celebrated its 20th Anniversary of manufacturing heat transfer products.

MAJOR FRANCIS T. BRADLEY (ret.) has been appointed divisional chief engineer for the Tripoli Area of Iraq Petroleum Co., Ltd., with headquarters in Tripoli, Lebanon. A graduate from the University of Sydney, Australia, be served in the Australian and British armies, and during the war was with the Indian Army and Navy as ordnance specialist. He served in the British Military Government in Berlin until recently.

ALONZO M. HARP, sales manager until recently for American Machine & Metals, Inc., East Moline, Ill., has been appointed general manager of Great American Industries, Inc., New York City, manufacturers of gas expanded cellular rubber and low temperature insulation board.

ALFRED P. SLOAN, JR., founder of the Alfred P. Sloan Foundation, has announced a group of 10 awards to the U. S. radio industry for "outstanding service in the cause of highway safety in 1948." The plan will be administered by the Automotive Safety Foundation, Washington, D. C., of which **PYKE JOHNSON** is president.

ARCH L. FOSTER, formerly refining editor of Oil & Gas Journal has been appointed editor of refining and gas processing for Petroleum Engineer Publishing Co. with headquarters at Dallas, Tex. He is well-known in the oil and automotive industries as a writer on fuel technology, lubricants, and other petroleum products and refining processes. He plans extended coverage of these subjects in his new position.

ROBERT L. SUTHERLAND, who has been a special research associate in theoretical and applied mechanics at the University of Illinois, has accepted a position as an assistant professor in mechanical engineering at the University of Iowa, Iowa city.

JOHN JOSEPH O'BLENIS is now design engineer at the NEPA Division of the Fairchild Engine & Airplane Corp., Oak Ridge, Tenn.

JOHN I. CICALA recently became chief, Fuels Section, Fuels & Lubricant Branch, Internal Combustion Engine Division at the U. S. Naval Engineering Experiment Station at Annapolis, Md. He was formerly research engineer for the Continental Aviation & Engineering Corp. in Detroit.

About

DAVID T. MARKS, formerly connected with Chrysler Corp., Detroit, is now design engineer with the Packard Motor Car Co., Toledo, Ohio.

FRANK A. PALLONE, now senior draftsman with the American Machine & Foundry Co. in Brooklyn, N. Y., had been a designer with United States Plywood, New Rochelle, N. Y.

HERBERT K. SACHS has become associated with the St. Louis Car Co. in St. Louis, Mo.

RUND W. LARSON is now owner of Larson's Service at Pasadena, Calif.

HOWARD A. REED, formerly chief draftsman, Chassis Division, Engineering Department of the Fruehauf Trailer Co. in Detroit, was recently appointed resident engineer with this company in Avon Lake, Ohio. He is in charge of the Engineering Department at the Avon Lake plant.

MICHAEL ANTONIO PARADISO, who had been design engineer with Douglas Aircraft Co. in Santa Monica, Calif., is now assistant group engineer, Sikorsky Aircraft, Division of United Aircraft Corp. in Bridgeport, Conn.

ROSS L. FRYER, JR., preceding his appointment as assistant mechanical engineer, Diesel Engine Division of the American Locomotive Co., Schenectady,, N. Y., was engine design and design analysis engineer for the White Motor Co. in Cleveland, Ohio.

THEODORE C. LASH has become a master mechanic with Morrison Knudsen de Sonora in Algodo Nes, Mexico.

WILLIAM A. GRAMBO, until recently a designer with the Milwaukee Hydraulics Corp. in West Allis, Wis., is now a tool designer in the Steam Turbine Department of Allis Chalmers Mfg. Co., same city.

LEONARD VELANDER, JR. has become a development engineer at the Goodyear Aircraft Co., Akron, Ohio, after having been a graduate student at the University of Minnesota in Minneapolis.

Members

ROBERT B. SHORT, formerly group leader, guided missiles at the McDonnell Aircraft Corp., is now assistant project engineer of the Guided Missile Division for this corporation in Robertson, Mo.

ROBERT F. KRUPP recently became associated with Gerber Products Co. in Oakland, Calif., as engineering research manager. Before joining this company he was a project engineer with the Columbia Steel Co. in Pittsburg, Calif.

LESLIE ARTHUR TOON is now in the employ of the Worthington Pump & Machinery Corp., Holyoke, Mass., as junior industrial engineer. Prior to this he held a similar position with the Carnegie Illinois Steel Corp., Homestead, Pa.

EDWARD T. McKAIN has become owner of Ed McKain Truck Equipment in Central Point, Oreg. He had been with the Standard Carriage Works of Los Angeles.

EDWARD H. LeTOURNEAU has accepted the post of assistant to the president of the Overseas Tankship Corp. in New York City. He was previously assistant general manager in the Marine Department of the Esso Standard Oil Co. (formerly Standard Oil Co. of New Jersey).

HARRY C. POWELL is now a design engineer at Northrop Aircraft Co., Inc. in Hawthorne, Calif.

GEORGE C. BENTLEY, recently graduated from Washington State College, Pullman, Wash., has become an engineer with the Boeing Airplane Co. of Seattle, Wash.

BOYDE C. CORMANY is factory representative for the Michigan Abrasive Co. in Detroit. He is in charge of sales and sales development for this company on the West Coast.

HEBER C. LAMAR recently became service manager for Northwest Ford Motor Coach Sales, Inc. in Milwaukee, Wis. Prior to this he was service representative with the Twin Coach Co. in Kent, Ohio.

FRANK W. WHEELER, recently graduated from Texas A & M College, College Station, Tex., is now employed as a trainee engineer for the Humble Oil & Refining Co. in Houston, Tex.

RONALD ALVIN HENDERSON was recently appointed executive vice-president and chief engineer of the American Trailer & Engineering Co., Ltd. in Honolulu, T. H. He was previously affiliated with the Continental Trailer & Equipment Co. in Honolulu.

R. J. MASIELLO has become general office representative, Office of the Superintendent of Inspection, American Airlines, Inc., La Guardia Field, N. Y.

LT.-COM. JAMES M. MASON, JR., and **LT. (j.g.) EDGAR LEE MOSSHAMER** spent the last two weeks of August on active duty in the Naval Air Reserve at Grosse Ile, Mich. Mason, research engineer with Ethyl Corp. for the past nine years, is acting as maintenance officer for Fleet Air Squadron 57, which services combat planes for tactical training missions by veteran pilots and combat crewman in the Reserve. Mosshamer, an automotive engineer for Socony Vacuum for the past 12 years, is serving as aircraft maintenance officer for Attack Squadron 60A.

GERALD E. HYNAN has become supervisor of the Standards Department, Defiance Plant, Central Foundry Division of General Motors Corp., Defiance, Ohio. He has been process engineer with this company.

CHARLES F. BUCHANAN, recently graduated from Michigan College of Mining & Technology, Houghton, Mich., is an industrial engineer with the Oliver Corp. in Battle Creek, Mich.

CARLETON H. MORRISON is now regional director in the Far East for the Kaiser-Frazer Export Corp. in Willow Run, Mich. He is located in Lanikai, Oahu, T. H. In 1947-48 he was SAE Journal Field Editor for the Hawaii Section.

NEW DEPARTURE EXECUTIVE CHANGES

FRANK J. MILLER has been appointed general sales manager of New Departure, Division of General Motors Corp., Bristol, Conn. He has been in charge of the New Departure Chicago office for 11 years. **WILLIAM T. MURDEN,** assistant general sales manager for the last five years at Bristol, has been transferred to Meriden, Conn., as resident manager of the division's plant in that city. Murden is a past vice-chairman of the SAE New England Section. **CHARLES D. McCALL,** formerly automotive sales manager in Detroit for New Departure Division, has been named manager of the company's Central Region with headquarters in that city. **HOWARD A. OFFERS,** sales engineer in the Chicago territory, becomes manager of the Mid-Western Region, Chicago, and **RAYMOND J. LYNCH,** engineer in the Chicago office, is now supervisor of engineering in both the Central and Mid-Western Regions.

MILLER

MURDEN

McCALL

OFFERS

LYNCH

WILLIAM C. JORDAN, far left, until recently general manager of the Airplane Division, Columbus, Ohio, has been elected vice-president and general manager of Wright Aeronautical Corp., GUY W. VAUGHAN, Curtiss-Wright Corp. president, announced. Jordan was vice-president and general manager of Steel Products Engineering Co., Springfield, Ohio. HORACE G. PRALL, left, has been appointed assistant general manager at Wright Aeronautical

JOHN D. TEBBEN was recently elected vice-president in charge of sales at the S-M-S Corp. in Detroit. He entered Government services in World War II and at the time of his discharge joined the H. A. Wilson Co. as assistant to the President and supervised their engineering policies. Just before the war he was general sales manager of the Metallurgical Division of the P. R. Mallory Co.

BERNARD A. JONES, head of the Technical Data Section, Research Laboratories of Ethyl Corp., will teach a course in technical report writing at Wayne University. He was the 1947-48 editor of the SAE Detroit Section's "Supercharger."

L. L. COLBERT, president of the Dodge Division of the Chrysler Corp., left Detroit by plane on Sept. 1 for Kansas City, Mo. to visit the Dodge dealers and inspect their facilities in the Missouri, Kansas and Oklahoma territory.

TURNER G. TIMBERLAKE is now assistant, Maintenance Division, Chief of Engineers, Department of the Army in Washington, D. C.

ROBERT R. JOHNSON has become heating and ventilating engineer for Ellerbec & Co., St. Paul, Minn. He had been with the Cleveland Diesel Engine Division of General Motors Corp., Cleveland, Ohio.

ROBERT F. BOSTOCK has been appointed superintendent at Ranger Aircraft Engines, Division of Fairchild Engine & Airplane Corp., Farmingdale, L. I., N. Y. He had been manager at Alloy Products, Inc., Marion, Ind.

FREDERICK FOSTER TRACY is an engineer trainee, Gulf Oil Corp., Odessa, Tex.

LLOYD D. BEVAN, assistant project engineer for the Airesearch Mfg. Co. in Los Angeles, had previously been powerplant engineer at the Bell Aircraft Corp., Buffalo, N. Y. He was 1947 secretary-treasurer of the SAE Buffalo Section and is now vice-chairman of this section.

WILLIAM A. BAKER is now owner of a company with the firm name of William A. Baker & Associates in Los Angeles.

FRANK B. QUACKENBOSS, JR., prior to becoming an engineer with the Air Transport Association in Washington, D. C. was connected with United Air Lines, Inc., San Francisco as an aircraft engineer.

JOHN B. CRAY is now service representative—field—for Reaction Motors, Inc. in Dover, N. J.

MORTON P. MATTHEW is in business for himself making scale product models at 721 The Alameda, Berkeley, Calif. This working model is a vertical three-stage refinery pump made almost entirely of cardboard. He was formerly project engineer for DeLaval Steam Turbine Co., Trenton, N. J.

LAWRENCE L. POHLMAN is now truck sales engineer—GMC trucks, for the Garber Buick Co. in Saginaw.

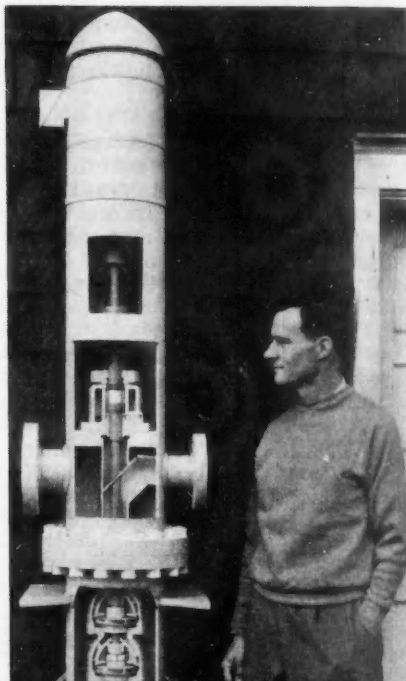
LLOYD LOWERY, who had been service manager with the Murphy Motor Co., Ltd. in Honolulu, T. H., recently accepted a similar position with Castner Garage, Ltd., in Oahu.

SAMUEL B. PARSONS, until recently with the Johns-Manville Corp., St. Louis, has now become sales engineer at Neiman Bearings Co., same city.

BYRON H. SHINN is a research designer at Pratt & Whitney Aircraft Co., East Hartford, Conn., after having served with Firestone Aircraft Co. in Willow Grove, Pa. He was company representative for Firestone for the SAE Cleveland Section in 1944 and 1945.

JOHN B. WILEY, sales engineer for the District Steel & Equipment Co. in Los Angeles, had been associated with the U. S. Flexible Metallic Tubing Co.

HOWARD L. OVERMAN has been appointed manager of the Tractor-Hardware Department at T. H. Davies, Ltd. in Hilo, Hawaii. He was previously with A. F. Stubenberg, Ltd. in Hilo. In 1946 he was chairman of the SAE Hawaii Section.



JEROME **BARTELS** has been appointed assistant professor of mechanical engineering at Polytechnic Institute of Brooklyn, where he will be in charge of undergraduate work in internal combustion engines. He had been instructor in mechanical engineering at New York University. During the war he was with the Navy at the Brooklyn Navy Yard.

WILLIAM K. **BELISLE** has joined Birger A. Guthe, Long Beach, Calif., distributor of automotive products, as sales and mechanical engineer. He had been service manager of Freeman A. McKenzie, Inc., of that city.

HENNING **KARLBY** has been made development engineer at the Rockwell Mfg. Co. in Pittsburgh, Pa. He had been connected with the Elastic Stop Nut Corp. of America in Union, N. J.

E. R. **LEEDER** is now general works manager for Lyon, Inc., Detroit. Prior to this he was affiliated with the F. L. Jacobs Co., same city.

JOHN G. **BURKE**, who recently resigned as vice-president of Cummins Diesel Engines, Inc., Pittsburgh, has been elected president of Metallurgical Supply Co., Tulsa. The company manufactures screw machine products, forgings, castings, and stampings.

LT.-COM. **HARRY J. HUESTER**, USNR, has been assigned to the executive office of the Aeronautical Standards Group, U. S Navy Bureau of Aeronautics, Washington, D. C. He had been liaison officer at the Air Materiel Command, Wright-Patterson Air Base, Dayton, where he was active in the SAE Dayton Section. The organization previously known as the Working Committee of the Aeronautical Board is now the Aeronautical Standards Group, and will continue standardization for aeronautical materials and processes for the Army and Navy, with cooperation by industry. A major part of this industry cooperation has been handled by technical committees of the Society.

JOSEPH **MINTON** has joined the Consolidated Edison Co., New York City, upon graduation from the College of the City of New York.

HENRY **WYSOR**, metallurgical engineer on the staff of the operating vice-president of Bethlehem Steel Co., retired from active service July 1 after 30 years association with that company. He will be succeeded by **JOHN K. KILLMER**, who joined Bethlehem in 1923 upon his graduation from Lehigh University. For many years active in SAE technical projects, Wysor taught at Layfayette College following his graduation from Virginia Polytechnic Institute.

MALCOLM H. LOVE has been appointed local manager of Shell Oil Co., Inc., Hilo, Hawaii.

JOHN G. STAPLER, prior to becoming chief of production engineering for the Stewart-Warner Corp., Indianapolis, Ind., was superintendent of quality control at American Machine & Foundry Co. in Brooklyn, N. Y.

HEDLEY DREHER has been appointed director of research at the Asbestos Mfg. Co. in Huntington, Ind., after having been connected with the Universal Friction Materials Co. in Kendallville, Ind.

ALFRÊD A. HEALY was recently made general manager at the Esha Co., Dubuque, Iowa.

WALTER F. PERKINS was recently appointed vice-president and general manager of the new Metal Products Division (which is the consolidated Shops and Piston Rings Divisions) at Koppers Co., Inc., Pittsburgh, Pa.

HOLGER S. SMITT, plant engineer at Gladding, McBean & Co. in Lincoln, Calif., was formerly employed at the GMC Truck & Coach Division in Pontiac, Mich.

F. T. GOULD, who had been Washington representative for the Breeze Corporations, Inc., is now sales manager of the Aircraft Standard Parts Co., division of the above corporation in Newark, N. J.

J. O. CHARSHAFIAN, Wright Aeronautical Corp., Wood-Ridge, N. J., and past-chairman of SAE Metropolitan Section, will conduct a course in aircraft engines at Brooklyn Polytechnic Institute.

WALTER LANE MOSS, JR., a recent graduate from Texas A & M, has joined Halliburton Oil Well Cementing Co., Bay City, Tex., as an engineer trainee.

OBITUARIES

ELMER McCORMICK

Elmer McCormick, for 12 years chief engineer of John Deere Tractor Co., Waterloo, Iowa, died Sept. 12 in Milwaukee. He was 58.

He was vice-president of the Society for the Tractor & Industrial Power Equipment Engineering in 1937, had been active in a wide range of SAE standards projects, and was for a number of years member or vice-chairman of the SAE Tractor & Farm Machinery Committee. He was a member of the SAE Technical Board, the Society's top technical group.

He joined Deere & Co. upon his graduation from the University of Illinois in 1914, having worked there as student draftsman. Following a brilliant career of engine and equipment designing he became chief engineer of that company within four years.

When the company purchased the Waterloo Gasoline Engine Co. in 1920, he was made sales manager, and seven years later was appointed sales manager of John Deere Tractor Co. Two years later he was again in engineering, and in 1932 became chief engineer of the company and its several affiliates.

NICHOLAS DREYSTADT

Nicholas Dreystadt, a vice-president of General Motors Corp. and general manager of the Chevrolet Motor Division, died Sept. 3 in Detroit. He was 59, and had been in poor health for some time.

Born in Germany, Dreystadt studied automotive engineering while working for Mercedes, and came to the United States in 1912 and joined GM as a mechanic at the Cadillac branch in Chicago.

In 1926 he became Cadillac service manager, and successively was works manager and general manager of the Cadillac Division. He was elected vice-president of the corporation in 1942 and was appointed Chevrolet general manager four years later.

ALEX BERTEA

Alex Bertea passed away very suddenly on August 4. He was president and chief engineer of Bertea Products, Pasadena, Calif. and was a nationally known designer of power boost systems.

Bertea was born in Switzerland 50 years ago and came to the United States in 1923. He attended schools and college in Switzerland and Germany.

In the past he was chief engineer at Fitzgerald Electric Co., later becoming associated with Adel Precision Products Corp., Los Angeles. He later formed a partnership with Ray Ellinwood known as Berwood Corp., of which he later became sole owner. Bertea Products Corp. was formed in 1943 and during the war manufactured de-icer equipment. Since the end of the war the company has been engaged in the manufacture of hydraulic equipment.

C. G. A. Rosen, left principal speaker at the dinner, with F. G. Shoemaker, toastmaster, and Past-President C. E. Frudden

Tractor Outlined

WAYS to cheaper and more reliable power production and transmission for diesel users highlighted the SAE National Tractor and Diesel Engine Meeting in Milwaukee Sept. 17-19. Backed by deductive thinking and testing that led to their emergence, these improvements indicated promise of still better things to come.

Biggest SAE gathering ever held in Milwaukee, the meeting totaled more than 700 in attendance and drew crowds to the individual sessions. Much credit for success, according to SAE Vice-Presidents George Curtis (Tractor & Farm Machinery) and Harry F. Bryan (Diesel), belongs to their respective Activity Meetings Committee chairman, Louis Gilmer (Tractor) and A. H. Fox (Diesel), and to C. T. O'Harrow, General Committee chairman. Past-President C. E. Frudden keynoted the meeting with his dinner talk on the common interests of the three groups brought together—tractor and farm machinery, construction and industrial machinery, and diesel engine. Dinner speaker C. G. A. Rosen gazed into his crystal on future tractors and road machinery and the engines they will require.

At technical sessions fuel and engine men advised of diesel fuel properties to seek and avoid to prevent deposits and boost performance. Additionally diesel design changes and wear-stoppers, horsepower-savers and shifting-easers stand out in sharp relief as progress milestones reported at the meeting.

The how-we-did-it contribution equalled the what-we-did one. Thinking that nurtured these advances from ideas to realities in the laboratory and the field was revealed for the first time, in most cases. Fuel test programs, engine performance studies and instruments used, hydraulic shift development principles, and the harnessing of new know-how to planetary gear making lay down creative patterns for others to follow.

Earth-moving and cultivating machine designers also argued rotary tiller design and payload rating of construction machines.

New diesel fuel and engine facts pointed both to the kind of nutrition engines need for better performance and to resistance to premature organic ills. Forces aimed at balancing delicate fuel-engine relationships were reported springing from widely divergent areas.

One engineer advocated lighter, more easily vaporized fuels for part-load operation. Volatility and cetane number will produce less deposits as engines run under light loads. He recommended that engines running long at light load or operating at unavoidable standby idling, be cleaned out periodically by short runs of high load. It's particularly important before shutting down an engine after continued low-load operation.

Hear World Viewpoint

Specially treated diesel fuel was felt to be the safest way to avoid premature engine failure from deposit formation. A worldwide viewpoint on diesel engine trends was brought to the meeting by two of The Netherlands' outstanding petroleum technologists who disagreed with this thinking. Although lighter and more expensive fuels are in demand in the future, they feel the pendulum will swing toward heavier fuels through development of troublefree powerplants, designed to consume heavier fuels.

Improvements At Milwaukee

The very ability, they emphasized, of the expensive diesel engine to use a cheap fuel has been its strong point. So far, hardly any attention has been given to this side of the problem in relation to high-speed diesel engines.

Considerable work has been done by them on improving the rate of injection, duration, and timing. Fuel pump plunger sets in two or three sizes would help control these factors toward greater engine efficiency, they suggested.

Whereas cetane number controls delay—volatility, viscosity, and specific gravity of diesel fuel are involved in combustion. But so complex is the process that it's impossible to derive a conception of "combustion quality" for these combined characteristics.

Studies on railroad diesel engines, detailed by a trio of researchers, show cetane number and heating value are two fuel properties which control cylinder pressure characteristics. For rated load railroad conditions the thermal efficiency of the engine is constant. Thus the railroad customer gets the most for his money by buying the heaviest fuel compatible with maintenance cost.

To help reduce engine maintenance costs, these engineers redesigned the injector so shock load, combustion roughness, and maximum cylinder pressure were reduced. The design change involved an increase in diameter of the injector plunger to retard start of injection and to maintain end of injection at about the same time as previously lapsed. Timing was arbitrarily retarded at the rated load condition by about 5 deg.

Said these engineers, this improved injector design bettered fuel efficiency by about 2% and smoke density dropped from a light grey haze to almost invisible.

The fuel situation from the farmer's standpoint was well summarized by a leading engineering executive. He said both gasoline and diesel tractor fuels are meeting increasingly stiffer competition for their portion of the barrel of crude. This means tractor fuel price will go up, but more efficient engines will counter this cost boost.

Diesel fuel is bucking a mushrooming demand for fuel for oil burners, which holds no brief for cetane number. And tractor distillate fuels are good cracking stock for high octane gasoline. Trend in small tractor engine design is toward use of regular gasoline. Eventually, it was predicted, this fuel will be used almost exclusively. Octane numbers will be used more efficiently.

Toward this end some felt it was not too fantastic to see alcohol-water-lead injection and dual-fuel systems, now being introduced for cars, trucks ,and buses, on farm tractors. At second glance, advised farm equipment engineers, this isn't too far-fetched because in certain kinds of operation tractors operate under varying loads. Thus such variations in octane appetite of their engines can be satiated by either of these fuel-stretching methods.

More exclusively on the engine side—though not divorced from fuel considerations—came word of further economies through reducing friction and power losses and cylinder and ring wear.

One group saw internal engine friction and power losses improved through application of available know-how and interchange of this information between various manufacturers. As a case in point, one engineer focused on the loss of 2 or 3 hp on a

Under the general chairmanship of **C. T. O'Harrow**, the following served as chairmen of the seven technical sessions of the SAE National Tractor & Diesel Engine Meeting: **A. W. Pope, Jr.**, **W. F. Joachim**, **H. L. Rittenhouse**, **L. D. Thompson**, **W. H. Worthington**, **C. E. Frudden**, and **C. A. Herbert**. This report is partly based upon discussions and 11 papers . . . "Studying Diesel Combustion with the Cathode Ray Indicator" by **W. C. Hadley**, **J. R. Hudnall**, and **A. E. Traver**, Socony-Vacuum Oil Co.; "A Railroad Diesel Engine Improvement Based on Study of Combustion Phenomena and Diesel Fuel Properties" by **H. W. Barth**, **F. A. Robbins**, and **H. C. Lafferty**, Electro-Motive Division, General Motors Corp.; "Fuels for Automotive and Railroad Diesel Engines" by **J. J. Broeze** and **C. Stillebroer**, Delft Laboratories, Royal Dutch Shell; "Influence of Fuel Composition on Deposit Formation in High Speed Diesel Engines" by **H. M. Gadebusch**, Detroit Diesel Engine Division, GMC; "The Relation of Rated Capacity to Pay Yards in Earthmoving Equipment" by **D. K. Heiple**, R. G. Tourneau, Inc.; "Cylinder and Piston Ring Wear in Diesel Engines" by **J. W. Pennington**, Caterpillar Tractor Co.; "Application of Hydraulic Transmissions" by **R. M. Schaefer**, Allison Division, GMC; "Planetary Transmissions for Agricultural and Industrial Tractors" by **H. W. Simpson**, consulting engineer; "Discussion of Power Losses in Tractor Engines" by **H. T. Mueller** and **K. L. Pfundstein**, Ethyl Corp.; "More Effective Utilization of High Octane Fuels" by **A. T. Colwell**, Thompson Products, Inc., and "Design and Power Requirements for Rotary Tillers" by **L. E. Lura**, Lavers Engineering Co. All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

tractor fan during a season. If the tractor maker would only take the time and avail himself of existing knowledge, he could, for a slight additional cost, properly proportion and design radiator and fan.

Same is true of the water pump, described at this session as a form of paddle wheel in a nondescript housing. Through research, power demands of a pump—generally 6 to 8 hp—have been halved.

Diesel life-sapping wear came in for a battle from engineers who tipped off operators and designers to cures for different types of wear. One said that cast iron resists scuffing much better than steel. Surface disintegration, stemming from surface fatigue, can be reduced by using machining and finishing techniques not injurious to the top surface layer.

Best safeguard prescribed against abrasive wear is good air and oil filters. Also chrome plating the top compression ring, tests show, reduce considerably cylinder and ring abrasive wear. Top catalysts for another type of wear, corrosion, are sulfur in the fuel and low-temperature operation, most engineers agreed.

Transmissions Discussed

From power production the spotlight turned to power transmission, with emphasis on planetary gearing and hydraulic shifting mechanisms.

It was said that the hydraulic transmission will continue to work its way into vehicles and farm machines as long as it continues to add something extra to their performance. Several samples of recent applications supported this contention.

Army Ordnance equipped tanks with the Torqmatic, a three-speed semiautomatic hydraulic transmission, because it reduced driver fatigue and gave the driver added time for other functions. Allis-Chalmers introduced its first postwar crawler tractor with a torque converter, reducing the number of speeds required from six to two. This installation permits engine operation at a high power factor so that the operator can get more work done. Result: 22% more dirt moved at 6% lower overall cost. Extra cost of the hydraulic transmission on this size tractor can be earned in a short period.

Wheel tractors do not lend themselves to a hydraulic transmission. First, average price of these machines in 1947 ran about $815. Second, the average farm tractor operates only a few hundred hours per year. Possibilities of earning back additional first cost by doing more work in less time is remote. And since a farm tractor is usually started in gear in which it operates, shifting is not a problem.

Advent of torque converters and fluid couplings were said to be particularly advantageous for planetary gearing, since it makes for best operation of such transmission. Its merits consist of reduction in gear tooth loading for longer life, no perceptible loss of momentum in shifting, and possibility of compactness.

Story behind these design improvements and operational hints lies in tests made by engineers who asked themselves: "What causes these troubles, limits performance, runs up operating costs?" Finding some of these answers led them to better ways of doing the job.

Such was the case with the three researchers who told about more economical fuel for railroad diesels and injector redesign. They conducted a laboratory test program with 33 fuel blends which led them to their discoveries. "This test program," they said, "has proven the value of laboratory development work with the aid of extensive instrumentation to improve a product and to reduce the owner's operating and maintenance expense."

The entire field of diesel fuels and engines, men from both areas pointed out, is one of finding what properties of one the other likes or dislikes.

Clues to sources of deposits in diesel engines came from, as one engineer remarked, "an investigation of the patient's habits." He studied the kind of deposits found at different points in the engine. He then examined deposits arising from individual types of malfunctions. This gave him some insight on properties of fuels and engine operating characteristics conducive to deposit formation.

The Dutch scientists, intent on continuing with lower quality diesel fuels, if possible, and modifying the engines to get better operation, are pushing ahead on a four-point investigation. They are studying the fuel's behavior in storage, in starting, during combustion, and its influence on maintenance. They point out that unless diesel engines are built to live with heavier fuels, a trend toward cheap engines requiring relatively expensive fuels will emerge. This points back to the gasoline engine.

A tool that lends the modern touch to these studies of engine and fuel performance is the cathode ray oscillograph. Rate of progress of oscillograph studies can be disappointingly slow, reported three engineers with a petroleum refining company. Required first are patience, knowledge of the engine, and thoroughness to avoid mistakes, they said.

Complete study of the engine's performance under every possible operating condition should be made before any study of fuels, new devices, or design changes are undertaken. This should include day-by-day analysis of indicator cards and a safe amount of checking. Otherwise some obscure engine characteristic is certain to bob up near the end of the program and upset a great many conclusions.

Survey Is Reported

Another technique for turning back to causes of specific effects, that of the reporter—but a research tool nevertheless—was used by the two engineers who surveyed the farm machinery industry on internal engine friction and power losses. They feel that pooling knowledge in this area to derive the best practices will obtain for all improved brake horsepower and fuel economy. Their work, they point out, is only a start in that direction.

To laboratory tests go credit for progress in curbing diesel engine wear. Inroads were made when engineers began analyzing wear and found at least

five members in the family—mechanical, scuffing, surface disintegration, abrasive, and corrosive wear. Once the classification was made, it was less difficult to detect causes and to affect remedies.

To alertness can be credited the comeback being made by planetary transmissions. New know-how is now being exploited to make possible full realization of the benefits of this better way of engaging speeds discussion brought out.

those mounted on rubber bushings and clutches.

Tines with flattened points work better and last longer than those with pencil points, because they tend to sharpen themselves by wearing the back edges.

Depending upon condition of the soil, speed of tractor, and the diameter of the rotor, speed of the rotor ranges from 180 to a high of 900 rpm. In hard, abrasive soil 300 to 400 rpm will prevent excessive wear and breakage of tines.

C. D. Sickert, left, chairman of the SAE Milwaukee Section and a member of the general committee, with Chairman C. T. O'Harrow of the general committee, R. J. Vedovell, chairman of the Tractor Section Auxiliary, Vice-President George W. Curtis, Tractor & Farm Machinery, and Vice-President Harry F. Bryan, Diesel Engine Engineering, at the SAE National Tractor & Diesel Engine Meeting registration desk

Current hydraulic servo controls overcome the objection to early planetary transmissions—a separate pedal or lever speed. And other improvements such as new long-life linings and facings for transmission breaks and clutches and new equipment for gear cutting and heat-treatment are helping the return of planetary transmissions. This together with engineering advances in planetary gear design make possible selection of the right planetary gear combination for any particular job.

Offers Suggestions

A researcher with hydraulic transmissions offered a word of advice to those developing new applications for these devices. The development group must find answers to these three questions: What will it do? How can it be "built in"? What can be combined by its use? He also noted that all successful installations gain something extra over the conventional transmissions they replace.

Discussions of rotary tiller design and construction equipment upheld the "down to earth" interests at the meeting.

The rotary tiller should be considered a supplement to the plow, although in some cases it has replaced the older farm implement, an engineer explained in setting up guides for designers of new types or models.

It is probable that sets of differently shaped and types of tines will be required to fit various soil conditions and applications, he said, but the spring mounted variety appears to be more successful than

Nine fundamentals offered by the speaker to guide rotary tiller designers were location of rotor with respect to the tractor wheels, type of tines, final drive to tines, hood location and construction, speed of rotor, vibration of the machine, depth regulation, horsepower required, and a method of eliminating trash—such as occurs heavily in sugar cane cultivation.

Given sufficient loading power, the payload of earth moving equipment is about 90% for sand, 80% for earth, and 70% for clay of the machine's rated capacity, a manufacturer's chief field engineer told the meeting.

Despite the use of the cubic yard measure and rate of payment based on that, final analysis on competitive tests of equipment has always been on a weight check.

The nature of the various types of sand, earth, clay, and other materials handled, as well as the moisture content and mixes seems to make more accurate computations impossible, and to many they do not seem necessary.

Traction, operator technique, and other factors introduce considerable variation in most calculations.

For all practical purposes the SAE Subcommittee on Yardage Rating of Bodies and Buckets has agreed that heaped capacity is the volume contained by the side sheets and by planes extending at a 1 to 1 slope above them, and from top of apron and tailgate until they meet overhead. This, with the cutting edge of the machine resting on the ground.

CALENDAR

British Columbia Group—Oct. 21

Vancouver, B. C. Developments In Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

Detroit—Oct. 18 and 25

Oct. 18—Small Auditorium, H. H. Rackham Educational Memorial Building, meeting 8:00 p.m. Jet Planes and Some of Their Problems—Rear-Admiral C. A. Nicholson, USN, assistant chief of the Bureau of Aeronautics for Design and Engineering.

Oct. 25—Small Auditorium, H. H. Rackham Educational Memorial Building. Junior Group Panel Meeting 8:00 p.m. Talks on Automatic Transmissions by three Junior members. Discussion to follow talks.

Metropolitan—Oct. 21

Hotel Pennsylvania; meeting 7:45 p.m. Inhibitor Action in Fuels and Lubricants—C. F. Prudden, Case Institute of Technology. J. E. Schipper, Jr., vice-chairman, Fuels and Lubricants, presiding.

Mid-Continent—Oct. 12

University of Oklahoma, Norman, Okla.; dinner 6:30 p.m. Economics Shape Truck Trends—Merrill C. Horine, Mack-International Motor Truck Corp.

Mohawk-Hudson Group—Oct. 19

Albany Garage Auditorium, Albany, N. Y.; get-together meeting at 7:45 p.m. (for members only). Semi-business meeting—introduction of new officers and committee chairmen followed by movies.

Northern California—Oct. 13

Hotel Claremont, Berkeley, Calif.; dinner 6:30 p.m. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

Fresno Division—Oct. 11

Fresno, Calif. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

Northwest—Oct. 19

Seattle, Wash. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

Oregon—Oct. 15

Portland, Ore. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

Philadelphia—Oct. 13

Engineers Club, Philadelphia; dinner 6:30 p.m. Fluid Couplings and Torque Converters—O. K. Kelly, engineer in charge of transmission development, General Motors Corp.

Pittsburgh—Oct. 26

Hotel Webster Hall; social hour 6:00 p.m. and dinner 6:30 p.m. Meeting at Mellon Institute Auditorium 8:00 p.m. The Gas Turbine as an Automotive Power Plant—E. B. Kerekes, Elliott Co.

Spokane-Intermountain—Oct. 18

Hotel Desert, Spokane, Wash.; dinner 7:15 p.m. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

Twin City—Oct. 25

Minneapolis, Minn. Developments in Fuels, Lubricants and Lubrication—R. J. S. Pigott, chief engineer, Gulf Research and Development, and president of SAE.

New Members Qualified

These applicants qualified for admission to the Society between Aug. 10, 1948 and Sept. 10, 1948. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (Aff.) Affiliate; (SM) Service Member; (FM) Foreign Member.

Baltimore Section
Kenneth P. Bowen (A).

British Columbia Group
Gilbert W. Plant (A).

Canadian Section
Ralph Biggar (A), Harold B. Chambers (M), Stuart P. Jones (A), Frederick Krailo (M), Colin Hendrie Mitchell (A), John A. Smith (J), Ronald M. Thomson (J).

Chicago Section
Elmer Joseph Krueger (A), Otto R. Last (J), F. L. Murphy (M), E. R. Walter (M).

Cleveland Section
Richard H. Albrecht (J), Clifford C. Lace (J), Irving A. Oehler (M), Donald H. Perry (J), Harold R. Russell (A).

Colorado Group
T. H. Kissell (A), Theodore A. Olson (A).

Dayton Section
Harry Madison Blank (M), John W. Caulder (SM), Morris J. Duer (M), Wm. J. Webster (A).

Detroit Section
Axel Floyd Leroy Anderson (M), Gayle H. Bowers (J), Loren E. Boysel (M), Robert Osborne Brines (J), Edward James Delahanty (M), Jack William French (M), William F. Helmrich (J), Deo Donald Lewton (J), Harold A. McHale (M), Lloyd Trent Petersen (A), Joseph Pizzo (M), Arthur M. Reibitz (M), George K. Ringe (M), Wm. H. Vaughn (M).

Hawaii Section
George M. Gilmore (A), Henry Hughes (A).

Indiana Section
Le Roy Rueter (A).

Kansas City Section
Dudley Herbert Grimm (J).

Metropolitan Section
Jerome Bartels (M), Herman G. Claussen (M), Thomas V. Douglas (J), William J. Fowler (A), Lt. (jg) Richard Charles Knoeckel, Jr. (J), Wilson S. Litzenberger (J), Max A. Morgenstern (J), Elmer Fred Nabstedt (A), John A. Scott (M).

Mid-Continent Section
R. S. Burgin (A).

Milwaukee Section
G. R. Layden (M), Stanley Victor Puidokas (J), Clair M. Robertson (J).

Northern California Section
James Wilmer Craft (J).

Northwest Section
Albert Hautenne (A).

Oregon Section
Norman A. Norene (M).

Philadelphia Section
John W. O'Hara (J), William Tauss (M).

Pittsburgh Section
David J. Giles (M), Cecil A. Lediard (A), George P. Rosser (A), Gustave A. Sill (J).

Southern California Section
John H. Grizzard (A), Chas. O'-Donnell Lee (A).

Texas Section
A. Grant Fewsmith (M).

Twin City Section
Donald Joseph Breining (A).

Virginia Section
R. L. Brown, Jr. (A).

Washington Section
Allen P. Blade (SM), Douglas Keith Bonn (A).

Western Michigan Section
Marvin J. Huizenga (J).

Outside of Section Territory
Richard C. Carson (A), Raymond H. Dietrich (M), Chas. B. Tichenor (A), Louis G. Wheeler (A).

Foreign
Harry Armitage (FM), England; Clive O. B. Beale (FM), England; Luis Arturo Buxton (J), Argentina; Neville Aspinall Clegg (FM), England; Sydney Richard Webb (FM), England.

Applications Received

The applications for membership received between Aug. 10, 1948, and Sept. 10, 1948 are listed below.

Baltimore Section
Robert Morris Foster.

British Columbia Group
Albert Murray Martin.

Canadian Section
Harold S. Aspinall, Bryan Alexander Ellis, Bruce John McColl, Harold William McFadden.

Central Illinois Section
Thomas Edward Hrodey.

Chicago Section
Kenneth H. Barnes, W. C. Dyer, Stephen T. Goode, Harry A. Hedland, Harold V. King, Jr., Bradford Eastman Phillips, Donald G. Reed, Earl B. Roberts, Morris J. Rowlands, Edmund

Carl Sedlack, Robert H. Whitney.

Cleveland Section
J. Jason Bigelow, Elmer R. Chokan, Joe Conn, Leslie W. Hoberecht, John B. Leece, John J. Novak, Elmer H. Redding, Julius J. Sabo, Martin L. Sheetz.

Dayton Section
William Bernard Smith.

Detroit Section
Charles Eugene Bierwirth, Joseph T. Dobbs, John A. Egan, Omer L. Foret, Charles Lewis Freel, Donald Richard Kinker, Don MacRae, George Miakinin, M. S. Riaz, William Kerby Steinhagen, Miczyslaw John Waclawek, Oscar J. Wesa, Laurence Harold White.

Hawaii Section
Francis S. Pugh, Nathan H. Tracy.

Indiana Section
Joseph F. Jamison, William August Peter Meyer, Stanley Clayton Tarrant.

Metropolitan Section
Frederick Behrens Capalbo, Pericle A. Chieri, Jules Louis Dussourd, Robert L. Eichenlaub, Nicholas Ferrigno, Howell Kermit Fesq, Anthony G. Fortunato, J. M. Harris, Robert V. Josephson, Sidney S. Linn, Robert R. Myer, Jr., Michael Schinagel, Irving Sheraga, Wendell E. Simpson, Everett H. Schroeder, Hugh S. Wagner, George W. Wunner.

Mid-Continent Section
Lawrence E. Murray.

Milwaukee Section
Joseph G. Atwood, William V. Benjamin, F. Burrows Esty, Aloysius Anthony Kachelmeier.

Mohawk-Hudson Group
Frank McKay Biggar, Jr., Kenneth I. Langwig.

New England Section
Frederick L. Cole, Charles L. Pulford.

Northern California Section
W. H. Braley, Carl E. Bremer, Henry M. Fujii, Howard Orrin Gaston, Charles Bert Graves, Charles H. McDonnell, Raymond J. Miniet, Harry C. Sage, Alford R. Smith.

Oregon Section
Robert McFarland.

Northwest Section
Robert Joseph Marhefka.

Philadelphia Section
William Elbert Liesman, Harry M. McCully, Jr., Leon Prager, Thomas F. Young.

St. Louis Section
Irwin E. Fuchs, Hulett Scott Ingersoll.

Southern California Section
Louis McNeil Ballard, Don G. Bryan, Jr., W. Elwood Jae, Edwin Chester Lowe, Irwin Louis Markowitz, Robert Stanford Schuyler.

Southern New England Section

Eugene Behun, Kenneth I. Fancher, William Richard Kramer, Lester L. Phillips.

Spokane-Intermountain Section
John P. Witkowski.

Syracuse Section
Vincent J. Himrod.

Texas Section
Raymond M. Dost, Robert G. Hughes, Theodore George Scheid.

Twin City Section
Ralph John Herrington, Joseph J. Hite, Lester E. Petter.

Washington Section
Alvin Fluger, Thomas M. Hopkins.

Wichita Section
Wilmur M. McMillan.

Outside of Section Territory
J. A. Durr, Ian Alexander Gray, Richard W. Hoyt, Leonard C. Neufeld, Donald B. Olen, Ray Leonard Overcash, Ernest Sewell, Jr.

Foreign
John Alden, England; Mervin E. Dullum, British West Indies; Sacit Abdullah Sumer, Turkey; Bent Raymond Walter, England.

Continued from P. 70

Deactivator Stabilizes Fuel in Stored Vehicles

Based on paper by
J. A. BOLT
Standard Oil Co. of Indiana

GASOLINES that are going to be stored long in automotive fuel systems need a metal deactivator to suppress the catalytic effect of metals on oxidation. They need more antioxidant, too.

These were the conclusions reached by the Gasoline Additives Group of CFR Motor Fuels Division, Coordinating Research Council, when the Council was asked by the Office of the Chief of Ordnance to find a solution to the wartime problem of gum formation on strainers, fuel lines, fuel pumps, and carburetors of stored equipment.

In essence, recommendations made to Ordnance in December 1943 and May 1944 were:

1. When either new or used vehicles are parked for extended periods, the gasoline (house-brand) should be stabilized by adding to the fuel tank a unit of mixed additives consisting of 3.0 g (active ingredient) of metal deactivator and 2.0 g (active ingredient) of antioxidant diluted to 4 oz in a suitable solvent. One unit of this additive mixture should be used in

vehicles with tanks up to 30 gal capacity. Larger tanks should be stabilized with correspondingly greater amounts.

2. For drive-away or run-out fuel for use in new vehicles the gasoline should:

(a) have an induction period by the ASTM D525-42T test of not less than 360 min

(b) contain not less than 5.0 lb approved antioxidant per 1000 bbl of gasoline

(c) unless certified as 100% virgin stock, contain not less than 9.3 lb of an approved metal deactivator per 1000 bbl of gasoline

Background for these recommendations included tests carried out earlier which showed that:

1. In copper steel tanks or in the presence of other parts of fuel systems containing copper, cracked gasolines, when not acid-treated, although stabilized with antioxidant, stored very poorly regardless of the induction period of the fuel.

2. Acid-treated cracked gasolines were more stable than the untreated fuels, but were affected by both terneplate and copper or copper alloys.

3. Straight-run gasolines stored favorably in the presence of all metals tested.

4. In accelerated oxidation tests in the presence of these metals or alloys, the induction period was decreased for all gasolines except straight-run fuels. The decrease in induction periods correlated well with actual storage life in the presence of these metals.

5. Untreated cracked gasoline containing conventional antioxidants stored favorably if sufficient deactivator was used to suppress completely the catalytic effect of the active metals on the cracked gasoline.

Tests run to check the validity of the recommendations were inconclusive because, while vehicles stored with gasoline containing the recommended additives stored favorably, so also did control vehicles stored without the additives.

Although the tests were inconclusive, Ordnance reported that the gum problem disappeared when the Group's recommendations were put into effect. It was concluded that the recommendations are adequate and that, with addition of deactivator, gasolines, containing appreciable quantities of cracked stock store satisfactorily for extended periods in automotive fuel systems. (Paper "Storage Stability of Gasolines in Automotive Fuel Systems," was presented at SAE National Fuels & Lubricants Meeting, Tulsa, Nov. 6, 1947. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Chronicles 20 Years of Fuels Rating

Based on paper by

ROYCE CHILDS

Waukesha Motor Co.

HIGHLIGHTS in the 20-year history of fuel rating under Cooperative Fuel Research and later Coordinating Research Council show how the principle of comparing operation of a test fuel with operation of a blend of reference fuels in a standard engine has been applied so successfully to motor fuels, automotive diesel fuels, and aviation fuels.

1928—The Cooperative Fuel Research Committee assigned to the Detonation Sub-Committee the problem of setting up a standard laboratory test method for rating the antiknock properties of fuels.

1931—The Sub-Committee had rec-

ognized the need for a standard test engine, reproducible reference fuels and a rating scale, and a test procedure; and all three needs had been met.

The Waukesha Motor Co. had developed a single-cylinder laboratory fuel-testing engine and accessories rugged enough to stand sustained periods of detonation. In the engine provision had been made for changing compression ratio during operation so that any fuel from low-octane tractor fuel to aviation fuel could be tested.

Dr. Graham Edgar of the Ethyl Corp. had suggested isooctane and normal heptane, both stable reproducible hydrocarbons, as reference fuels. For the rating scale, isooctane rated 100 and normal heptane 0. Fuel antiknock ratings were to equal the percentage of isooctone in a blend of isooctane and normal heptane which exactly matched the knock level of the test fuel when run in the test engine.

A tentative test procedure was adopted.

1932—Ratings made on the CFR laboratory equipment were compared with the behavior of the fuels in road tests at Uniontown, Pa. Equipment and procedure were modified to bring laboratory test results into closer correlation with road test results. The improved method was termed CFR Motor Method to distinguish it from the older method, called CFR Research Method. The Research Method was not discarded because it had proved itself an indispensable aid to refiners and engine developers in improving engine combustion characteristics.

CFR Develops Diesel Test

1933—Progress in measuring the ignition properties of diesel fuels was summarized at the World Petroleum Congress held in London. It was revealed that, with the increasing use of diesels for automotive and industrial use and the change in available fuels brought about by new refinery cracking processes, laboratories throughout the world had been working on methods of testing ignition quality of diesel fuels. The Anglo-Persian Oil Co. of England and the Royal Dutch Shell Co. had been measuring the ignition delay period in operating engines. The Waukesha Motor Co. had aimed at measuring ignition quality of fuel by determining the compression ratio necessary to ignite the fuel. The ignition-delay method was recognized as corresponding more closely to actual operating conditions. The critical-compression-ratio method was recognized as being simpler and easier to maintain and as providing a fuel rating that revealed both combustion characteristics and starting characteristics.

Royal Dutch Shell had made another major contribution—it was principally through their efforts that cetene and alpha methylnaphalene were established and made commercially available as reference fuels.

Later, the several investigations being made in the United States were combined in a voluntary compression-ignition research group. As a result of their cooperative studies of test methods and reference fuels, cetene was replaced with cetane—a more stable reference fuel of lower ignition temperature. The group became the CFR Automotive Diesel Fuel Division.

1938—The Division tried out six systems of instrumentation for its ignition-delay method, known today as the Coincident Flash Method, at the Shell Laboratories at Wood River, Ill. The Waukesha equipment was approved.

ASTM has since published the procedure as "Proposed Method for test for Ignition Quality of Diesel Fuels."

New Gasoline Tests Added

1939—The CFR Committee approved a new test, the CFR Research Method 1939. This slow, 600-rpm test gives practically the same results as the

older Research Method, but it is more convenient. Today, both tests are run and the double ratings used to indicate fuel sensitivity to operating conditions.

1940—CFR appointed a committee to develop a method for rating aviation fuels. This group modified the CFR engine for testing motor fuels and changed the instrumentation to measure temperature rise in the combustion chamber instead of pressure rise. Normal heptane and isooctane were specified as the reference fuels for the 0-100 range of the knock scale and isooctane plus TEL for above 100.

CFR approved the method and designated it CFR Aviation Method (1-C).

1941—A group of laboratories began work on developing a method for testing aviation fuels under supercharged conditions. The instrumentation and technique they evolved differed radically from older ones. Instead of rating according to pressure or temperature rise, the power output of the engine is compared under standard conditions. Fuel-air ratio is varied and supercharge pressure is adjusted to maintain constant knock. Results are plotted as curves of power output versus fuel-air ratio. Curves for test fuels are compared with curves for standard reference fuels to rate the test fuel under various operating conditions.

1948—These five methods—two motor fuel methods, one diesel fuel, and two aviation fuel methods—comprise the standards by which fuels all over the world are rated. The Coordinating Research Council has taken over the work of Cooperative Fuel Research, and efforts are being made all the time to improve the accuracy and convenience of the methods. Although many modifications have been made in apparatus and procedure, the very earliest test engines when brought up to date and run according to today's technique, will give the same results as new engines leaving the factory today. (Paper "Laboratory Engines for Fuel Rating," was presented at SAE Milwaukee Section meeting, Waukesha, Wis., May 7, 1948. This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Seek Ways to Control Surface Finish Quality

Based on paper by
C. R. LEWIS
Chrysler Corp.

CHARACTER as well as roughness of a machined suface is taking on added significance in the light of design and manufacturing progress.

Measurement of surface height irregularities—the present finish quality parameter—is good only so long as surfaces are geometrically similar (having same shape and pattern irregularities, differing only in size).

This means that surfaces finished by different methods cannot be compared directly by roughness height measurement alone. Thus the character of a diamond bored surface will differ from one that's honed. All these surface irregularity features not readily measurable are conveniently labelled surface character.

Fortunately, conventionally finished surfaces are sufficiently similar for roughness measurements to give some indication of surface performance. But unconventionally finished surfaces now in use—such as shot peening and metal spraying—prove present instruments quite inadequate.

Surfaces vary in performance with design and operating conditions. One kind of crankshaft finish might suit one engine, but not another. Wearing

surfaces in particular are sensitive to finish.

For a given surface type, wear rate generally decreases as the surface is made smoother. This tempts designers to specify as-smooth-as-possible a finish to reduce wear. But wearing surfaces cannot be manufactured without geometrical or dimensional tolerances and they cannot be held in place rigidly without deflections under load; therefore two mating surfaces seldom, if ever, fit exactly the way the designer intended.

The familiar run-in process removes these maladjustments through initial wear. Too rough a surface produces so severe an initial wear that the worn-in condition becomes a worn-out one, with no period of satisfactory operation. Too smooth a surface gets so litle initial wear that either adjustments in fit may be necessary, or failure by seizing and scoring results.

Optimum surface smoothness may vary widely with different surface characters and different operating conditions.

Job of the SAE Surface Finish Committee is to establish criteria of surface finish quality, including both roughness and character, and to develop standards providing a common reference point for work in this field. Another serious handicap to be overcome is lack of physical standards for surface quality. (Paper "The Present Status of Surface Finish Control," was presented at SAE Summer Meeting, French Lick, June 7, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25c to members, 50c to nonmembers.)

Diesel Alternator Built for Rail Use

Based on paper by

N. H. WILLIS

Waukesha Motor Co.

WAUKESHA is now producing a diesel-engine-driven alternator unit to supply power for parasite-load requirements of railway cars which meets the requirements drawn up by a committee of the Association of American Railroads.

The committee called for a 25-kw, 220-v, 3-phase, 60-cycle unit to provide a-c power for air conditioning, lighting, and other electrical power needs. The diesel engine was to burn the fuel used by railroad diesel locomotives and was to operate 7000 hr without overhaul.

To fulfil these requirements, Waukesha coupled their Model 190DLB 6-cyl engine through an hydraulic coupling to a special alternator.

The engine has a 3 3/4-in. bore and 4-in. stroke and is rated at 60 hp at 1800 rpm. It is equipped with special manifolding, a front-mounted direct-driven water pump, filters for fuel and lubricating oil, and a large electric starting motor.

The Twin Disc hydraulic coupling cushions impacts created by either the engine or the alternator.

The alternator was developed to meet railway car needs. It had to be small in diameter because diameter could not exceed height of cylinders plus oil pan. To compensate for the small diameter, it was made longer than usual, although the added length increased the problem of heat dissipation.

The alternator is cooled by recirculated air. Fan blades attached to the shell of the hydraulic coupling operate in a double-scroll housing with outlets spaced 180 deg apart, forcing air through heat exchanger tubes located along both sides of the alternator field frame and between it and twin radia-

tors mounted one on each side of the alternator.

Alternator air is cooled in the heat exchanger. Some air returns through the air gap over the field coils. The remainder passes over the slip rings and through the hollow armature shaft to absorb more heat before reaching the fan suction and recycling. This method of cooling permits the alternator to be entirely enclosed, thereby excluding moisture and dirt.

The alternator and air conditioning unit are mounted on small roller-bearing wheels, which are isolated from the unit by vibration-arresting rubber mountings. The wheels roll on tracts, permitting either unit to be withdrawn for servicing or removal—or even for test operation.

Frequency of the alternator must not vary beyond the limits of $58\frac{1}{2}$ and $61\frac{1}{2}$ cps for operation of fluorescent lights and other electrical devices. Therefore, engine speed must be controlled within plus or minus 90 rpm. If the fuel pump were regulated directly by an engine-driven governor, the error of the governor plus the normal slip range of the coupling might exceed the permissible variation. To avoid this difficulty, the fuel-injection pump rack is controlled by a governor driven by a synchronous motor drawing its energy from the alternator. In this way, the engine is governed accurately in accordance with alternator speed. A second governor driven from the engine serves as an overspeed control in case the electrically-driven governor fails.

The net alternator output is 25 kv. It is capable of handling sudden heavy loads such as starting a 15-hp motor, even when partially loaded, without dropping voltage enough to dim fluorescent lights.

A 5-10 ton capacity air conditioning compressor is driven by a 2-speed electric motor.

This system was scheduled for installation on a number of new cars being built during the summer. For one railroad, the diesel alternators are to supply power for air conditioning, fluorescent lighting, water coolers, and even for electric heating for the spring and fall. (Paper "Engines Operating on Propane and Diesel Fuels for Air Conditioning and Generator Operator on Railway Passenger Cars," was presented at SAE Milwaukee Section meeting, at Waukesha, Wis., on May 7, 1948. This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Hot Cup Controls Diesel Combustion

From paper by

J. B. FISHER

Waukesha Motor Co.

FAST, controlled combustion is essential to high-speed diesels—and Waukesha has found a way to get it.

Diesel-engine buyers want maximum power for given displacement. The way to increase horsepower per cubic inch displacement is to raise bmep and engine speed. As these factors go up, so must the speed of combustion.

Most desirable time for achievement of maximum combustion pressure is 12 or 14 deg ATDC. As much as possible of the fuel should be burned at maximum pressure because fuel burned after the piston is descending causes smoke and low bmep and fuel burned too soon results in high shock loads, excessive vibration, and high maintenance expense. That means that speed of combustion must be very accurately controlled.

Waukesha does it by igniting the fuel as it enters the chamber, burn-

ing half the air quickly in a hot combustion cup, and burning the remainder of the air over the piston after a very short delay. The hot cup in the lower half of the combustion chamber increases in temperature with speed, acting like an automatic fuel pump advance to hasten ignition of fuel. The hot cup is so effective in one engine that it gives excellent performance from 800 to 2400 rpm without change in fuel pump setting.

The air to be burned over the piston is divided into two compartments connected by an orifice in the hot lower half of the chamber. The mixture is swirled at high speed in these pockets so that it will complete combustion before the piston goes far on its power stroke. (Paper "Factors Influencing the Design of Modern High-Speed Diesel Engines," was presented at SAE Milwaukee Section meeting, May 7, 1948. This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Expounds Design Philosophy For Electrical Equipment

Based on paper by

J. H. BOLLES

Delco Remy Division
General Motors Corp.

(This paper will be printed in full in SAE Quarterly Transactions)

PASSENGER car electrical equipment is designed and manufactured as economically as possible. If we receive too many complaints it is not good enough; if we get no complaints, it's too good.

We expect the car owner to get 30,000 to 50,000 miles of carefree service, depending on the operation. As yet there is no magic wand to pass over passenger car equipment for converting it to heavy-duty equipment good for 100,000 miles.

If you are seeking heavy-duty, 100,000-mile service, you must start with heavy-duty equipment. With proper installation and maintenance, heavy-duty equipment today can give you this service.

New things electrical are in store for the immediate future. An overrunning clutch for 12 and 24-v starting motors is being developed. A starting motor recently perfected operates with compressed air for cranking diesel engines. It is useful in oil fields, mines, and places where batteries and other electrical equipment are hazardous.

Waterproof distributors and coils, like those used on tanks during the war, now are available. They are practically submersionproof, desirable for floor-mounted engines on buses. Electronic ignition systems have been operated experimentally; but they will not be in production for some time since engines of the near future won't need them. (Paper "Electrical Equipment and Its Application," was presented at SAE National Transportation Meeting, Philadelphia, March 31, 1948. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Air Force Probing Cold, Supersonics

Based on paper by

Major-Gen. L. C. CRAIGIE

U. S. Air Force

WINTERIZATION of aircraft and equipment as well as supersonic flight continue to take top priority in

the Air Force research and development program.

Better solutions to familiar old problems of cold-weather flying—such as wing and propeller deicing, cold engine starting, cabin and cockpit heating, and low temperature lubrication—are being sought.

The answers may be found with the help of the recently completed climatic hanger in Florida. In this hanger it's possible to test equipment under temperatures from −60F to +180F. It is big enough to test several airplanes and lots of equipment at the same time.

Some other cold-weather challenges engineers must meet are situations such as these:

1. Moving an airplane out of a hanger into extreme cold may crack the plexiglass canopy or windshield.

2. If you drop a piece of fuel hose on the ground and leave it exposed to soak up cold winter air, it may shatter to pieces.

3. Extreme cold some times makes it necessary to preheat preheaters.

Just as hot a subject in military aviation as cold-weather operation is supersonic flight. The problem of providing adequate test and development facilities for work in this new realm is a real one. Industry cannot afford to maintain facilities to develop such aircraft. While an experimental airplane could be built for $25,000 to $100,000 only a few years ago, it runs into millions today.

A program is under way to provide such test and development facilities. An Air Engineering Development Center planned will include wind tunnels and high-speed units capable of duplicating atmospheric conditions at high altitudes.

The Center will cost a lot. The Air Force hopes that Congress, at its next session, will see fit to appropriate funds for the program. (Paper "The Role of Research and Development in Insuring Effective Air Power," was presented at SAE New England Section, Boston, April 6, 1948.)

Student News

Northrop Aeronautical Institute

NAI Student Branch had an entire TWA Constellation crew as guests at the July 22 meeting.

Capt. Evan Lewis gave an account of the crew preparations that must be made before actual takeoff. Flight Engineer Jack Evans listed the duties of his job: on the ground to check fuel load, look for malfunctionings, check with maintenance, and run flight tests; in flight to control the engines, regulate the air conditioning, check the electric system, and perform a multitude of other functions.

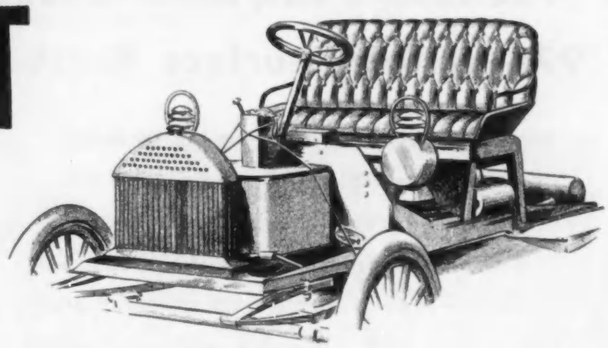
Flight Officer Elmo Jones, Stewardesses Louise Higgins, and Toni Theme added verbal sketches of their duties aboard the "Connie".

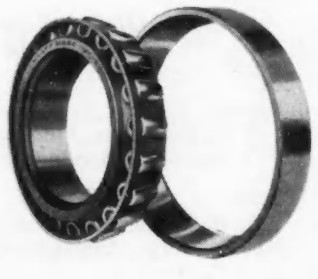
—R. L. Hixson, Field Editor

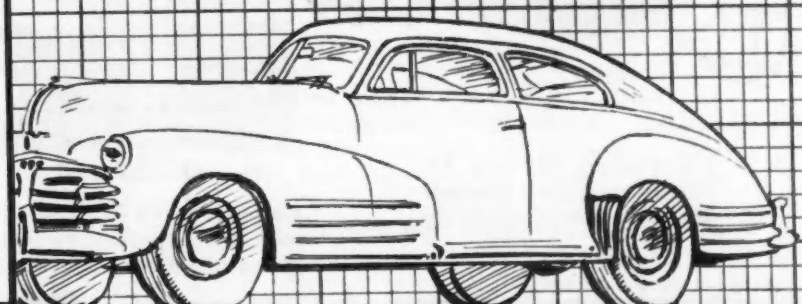
NAI Student Branch members met on July 28 to see a U. S. Army film, "The Story of the Helicopter" and to hear one of their stress and aerodynamics instructors, Holland-born and trained Peter J. Servass discuss helicopter design and development.

Servass pictured the differences in air circulation patterns encountered around helicopters in hovering, ascending, and descending. He outlined methods employed to reduce the adverse effects of forward motion on a fixed blade. Cyclic pitch systems are a comparatively recent innovation, he pointed out.

The word "helicopter" is derived







from Greek words for spiral and wing, Servass explained. He contrasted the basic principles of the helicopter and the autogyro.

Change of Address

So that your SAE mail will reach you with the least possible delay please keep SAE Headquarters and the Secretary of your local Section or Group advised of any changes in your address. Such notices should be sent to:

1. Society of Automotive Engineers, Inc., 29 West 39th St., New York 18, N. Y.
2. The Secretary or Assistant Secretary of your Section or Group at the addresses listed below:

Baltimore
R. D. Taber, Koppers Co., Piston Ring Div., Bush & Hamburg Sts., Baltimore 3, Md.

Buffalo
Robert D. Best, Fredric Flader, Inc., 583 Division St., N. Tonawanda, N. Y.

Canadian
C. E. Phillips, Perfect Circle Co., Ltd., 175 Wicksteed Ave., Leaside, Ont., Can.

Central Illinois
K. J. Fleck, Caterpillar Tractor Co., Peoria, Ill.

Chicago
T. A. Scherger, Studebaker Corp., Main & Bronson Sts., South Bend 27, Ind.

Cincinnati
W. A. Kimsey, R. K. LeBlond Machine Tool Co., Madison Ave. & Edward Rd., Cincinnati 8, Ohio

Cleveland
(Miss) C. M. Hill, 7016 Euclid Ave., Cleveland 3, Ohio

Dayton
R. S. Goebel, Production Control Units, 901 Shroyer Rd., Dayton 9, Ohio

Detroit
(Mrs.) S. J. Duvall, Detroit Office, SAE, 100 Farnsworth Ave., Detroit 2, Mich.

Hawaii
E. G. McKibben, Pineapple Res. Inst., P.O. Box 3166, Honolulu 2, T. H.

Indiana
R. P. Atkinson, Allison Div., General Motors Corp., Indianapolis, Ind.

Kansas City
F. V. Olney, Gas Service Co., Kansas City Mo. Div. 842 Grand Ave., Kansas City 6, Mo.

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Northwest
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Oregon
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Philadelphia
Laurence Cooper, Autocar Co., Lancaster Ave., Ardmore, Pa.

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St. Louis
R. T. Adolphson, Sunnen Products Co., 7910 Manchester, St. Louis 17, Mo.

San Diego
H. L. Stone, 1561 Catalina Blvd., San Diego, Calif.

Southern California
C. L. Fernau, Standard Oil Co. of Calif., 605 W. Olympic Blvd., Los Angeles 36, Calif.

Southern New England
C. O. Broders, Pratt & Whitney Aircraft Div., United Aircraft Corp., 400 Main St., E. Hartford, Conn.

Spokane-Intermountain
J. F. Conner, Auto Interurban Co., W. 508 Cataldo, Spokane, Wash.

Syracuse
W. F. Burrows, Aircooled Motors, Inc., Liverpool Rd., Syracuse 8, N. Y.

Texas
E. C. Steiner, OEM Industries, 301 N. Justin St., Dallas, Texas

Twin City
R. J. Strouse, Mack-Int'l Motor Truck Corp., 2505 University Ave., St. Paul 4, Minn.

Virginia
S. L. Baird, Fairfield Transit Co., R.F.D. 1, Sandston, Va.

Washington
H. A. Roberts, G. M. Roberts Brothers Co., 17th & U Sts., N. W., Washington 9, D. C.

Western Michigan
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Wichita
M. L. Carter, Southwest Grease & Oil Co., Inc., 220 W. Waterman, Wichita 2, Kansas

GROUPS

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Burdette Trout, Truck Parts & Equip, Ltd., 1095 Homer St., Vancouver, B. C., Can.

Colorado
S. G. Scott, Fenner Tubbs Co. 1009 E. Fifth Ave., Denver, Colo.

Mohawk-Hudson
C. M. Myers, Reo Motors, Inc., 149 B'way, Menands, Albany, N. Y.

Salt Lake
H. C. Slack, Fruehauf Trailer Co., 1082 S. Second W., Salt Lake City, Utah

Williamsport
J. W. Hospers, Lycoming Div. Avco Mfg. Corp., 1515 Park, Williamsport, Pa.